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ABSTRACT

A study identified the essential educational topics and the level of proficiency perceived to be required in these topics for selected two-year engineering technology programs in North Carolina. The four curricula studied were mechanical engineering technology, mechanical drafting and design technology, manufacturing engineering technology, and industrial engineering technology. Respondents to a questionnaire included 48 graduates, 49 employers, 39 North Carolina instructors, and 42 out-of-state instructors (45 percent return). Respondents identified educational topics they perceived as essential for each of the four programs. Statistical analysis techniques used to identify these topics as essential were the frequency of response to proficiency levels and factor analysis. Proficiency levels required in classwork and laboratory were identified for each topic in each of the programs using frequencies of response. Differences in the opinions of employers, graduates, North Carolina instructors, and national instructors were determined for each topic in both classwork and laboratory. Topics common to more than one program were identified. Conclusions were that each curriculum was perceived to be unique, the four subgroups of respondents generally agreed regarding topics in each curriculum, and discrepancies exist between respondent opinions and existing curriculum guides. (Appendixes include summaries of findings and correspondence.) (YLB)

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ASSESSMENT OF KNOWLEDGE AND SKILLS
NEEDED IN
SELECTED ENGINEERING TECHNICIAN FIELDS:
MECHANICAL/MANUFACTURING/INDUSTRIAL

Prepared for the
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CHAPTER I

INTRODUCTION

The evolution of engineering technology education in North Carolina over the past twenty-five years has resulted in the development of two-year engineering technology programs in many of the public community and technical colleges. Some programs have their own departmental identity in an institution while others are within a technical or trade-oriented department. They may or may not be accredited by the Accreditation Board for Engineering and Technology (ABET). The administrators and instructors in direct charge of these engineering technology programs have a variety of backgrounds, not necessarily in engineering, while engineering technology instructors generally have engineering degrees and experience. Even though curriculums vary somewhat among institutions, there is a significant degree of uniformity statewide due to curriculum standards and curriculum development activities of the State Department of Community Colleges over the past twenty-five years. Recent rapidly changing technology in industries that employ engineering technicians has made it difficult for instructors and institutions to maintain up-to-date curriculum content and to keep laboratory equipment current with industry practices. This study represents one effort at the state level to support and provide leadership for those institutions with engineering technology programs.

STATEMENT OF THE PROBLEM

The growth of engineering technology education in the last twenty-five years has been affected by three major factors: (1) the large commitment of public funds to this purpose; (2) the widespread development of both two-year and four-year programs of engineering technology; and (3) the rapid growth and change in technological fields. These factors have resulted in the rapid growth of two-year programs, the education of advanced level technicians in both two- and four-year engineering technology programs, and the challenge to keep abreast of technological changes affecting the field.

One result of this growth has been the rapid change in educational requirements in engineering technology programs. These changes have come about due primarily to the influence of computers in the workplace and to international competition issues. Entirely new industries and new methods of production have been developed within the last ten years.

There has been a need to share information regarding what graduates, employers, and instructors feel should be included in the two-year engineering technology programs in North Carolina because maintaining up-to-date competency-based curriculums is vitally important to the effectiveness of an institution. There has been a particular need for research to identify and describe the educational topics that should be included in programs to educate engineering technicians. Therefore this study was conducted to assess the educational topics (or components) required to properly prepare these engineering technicians.

QUESTIONS TO BE ANSWERED BY THE STUDY

The purpose of this study is to identify the essential educational topics, and the level of proficiency perceived to be required in these topics, for selected two-year engineering technology programs in North Carolina. This study seeks to answer four basic questions:

1. What educational topics are needed currently in two-year curriculums in Mechanical Engineering Technology, Mechanical Drafting and Design Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology as perceived by the respondents?

2. What levels of proficiency are required in classwork and laboratory for each educational topic of each curriculum, as perceived by the respondents?

3. What are the differences in opinion held by the subgroups of respondents concerning which topics should be in these curriculums?

4. Which of the topics are common to two or more of the curriculums being studied?

SIGNIFICANCE OF THE PROBLEM

The need to identify educational topics required in engineering technology programs is significant for several reasons:

1. Technology has been changing rapidly in recent years in the fields being surveyed.

2. Educational topics and the level of proficiency to be developed in classwork and laboratory needs to be identified for the North Carolina Community College system.

3. The opinions of employers, graduates, and instructors concerning which topics to include in a two-year engineering technology program should be studied and compared.

4. Educational institutions need current information on the relative importance of educational topics in engineering technology programs.

SCOPE OF THE STUDY

The basis for this study was an inventory of educational topics compiled into a questionnaire from a review of the literature, which was then reviewed and modified by a state and national panel of experts in the field of engineering technology education. The questionnaire was administered by mail to selected engineering technology graduates from North Carolina institutions, selected employers of these graduate engineering technicians, engineering technology instructors in North Carolina institutions, and engineering technology instructors in ABET accredited two-year programs in other states. The survey was conducted for four widely recognized two-year engineering technology curriculums--

Mechanical Engineering Technology, Mechanical Drafting and Design Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology.

The study was primarily concerned with identifying the educational topics and the level of proficiency perceived to be required in these topics in four engineering technology curriculums. However, it also allowed comparison of opinions between each of the different groups of respondents.

Statistical methods including frequencies and factor analysis were used to provide descriptive information from the data collected.

ASSUMPTIONS

The following assumptions were made regarding this study:

1. Engineering technology graduates, employers, and instructors would respond to a questionnaire to identify the educational requirements of these curriculums.

2. Engineering technology graduates, their employers, and their instructors would be in the best position to provide information about the educational topics for this group of educational programs.

3. Engineering technology instructors outside of North Carolina in programs that are accredited by the Accreditation Board for Engineering and Technology (ABET) are an appropriate group to include in determining opinions about the educational topics required in engineering technology curriculums.

4. An adequate number and percentage of those surveyed would respond to the questionnaire.

5. The perceived educational topics required in an engineering technology curriculum could be determined using a mailed questionnaire approach.

LIMITATIONS

As with all research efforts, this study was subject to certain limitations. Only selected graduates, employers, and instructors involved with the four engineering technology programs were surveyed. While other individuals, such as engineering technology administrators or other graduates who were not surveyed may have had valid opinions regarding these programs, inclusion of these other groups was not within the scope of this study. Another limitation was that all institutions that offer engineering technology programs in states other than North Carolina were not surveyed. Although there are over 500 institutions that offer engineering technology programs in the United States, it was decided that the interest in professional development and in quality education of instructors in ABET accredited programs would provide a representative standard for the field.

DEFINITION OF TERMS

Topic - A broad area of knowledge or skill which is involved in the preparation of individuals for employment in a specified field. Not necessarily equivalent to a course. Its emphasis in a curriculum would be dependent, among other things, on the level of proficiency required.

Engineering technology - That part of the technological field which required the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities. It lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer (ABET, 1983.)

SUMMARY

The diversity of settings and challenging positions in which engineering technicians function raises questions about both the educational topics needed to prepare them for jobs in the field, and the degree of similarity between the opinion of graduates, employers, and instructors as to what should be in the program. The purpose of this study is to identify the educational topics and the level of proficiency perceived to be required in these topics in engineering technology programs. It seeks to provide descriptive data about the relative amounts of each topic (reported separately by class and laboratory) that should be included in each curriculum, to identify the topics common among the programs studied, and to provide a comparison of opinions among those subgroups responding to the questionnaire. A questionnaire was developed and administered to graduates, employers, instructors in North Carolina institutions, and instructors in other states with ABET accredited engineering technology programs. Descriptive statistics were used to provide summary information from the data collected.

CHAPTER II

REVIEW OF LITERATURE

A search for literature addressing educational topics and the level of proficiency required in mechanical/manufacturing/industrial engineering technology programs resulted in several sources that were used in this study. Items were supplied by colleagues, by the library of the Department of Community Colleges and the library of the researcher.

The review of literature was grouped into sections titled "study design and inventory development" and "topics required in engineering technology programs." A summary of the literature reviewed is found at the end of the chapter.

STUDY DESIGN AND INVENTORY DEVELOPMENT

To design the study methodology and develop the inventory for this study it was necessary to review literature on the methodologies and formats of inventories used in other similar studies. This review provided information on the usefulness and acceptability of this type of inventory for data collection. It helped determine study methodology, the type of inventory to use, and the type of data to collect. It also provided information on the success of other studies using this method of determining educational requirements of specific job classifications.

Edwards and Roberson (1979) conducted a study to determine basic science and mathematics topics most needed by engineering technology graduates. This National Science Foundation-supported study was conducted for engineering technology graduates of Wake Technical Institute, Raleigh, North Carolina. Response frequencies, Chi square, and correlation coefficients were the statistical procedures used in the study. A summary of basic science and mathematics topics most needed by graduates of six engineering technology programs identified topics that were essential (E) and those that were desirable (X) for various topics in science and math courses. See Appendix A for the summary table from that study.

Gourley (1984) conducted a study of job competencies of engineering technology administrators using a self-assessment inventory developed with the assistance of a national panel of experts. A variety of statistical procedures were applied to the data, including the ranking of means, Chi square, the General Linear Models procedure, and correlation coefficients. Factor analysis was also used to group the seventy-three competency statements into nineteen factors composed of competencies that were similar in nature. The study covered significant research related to competency inventories and the use of statistical procedures for analyzing such inventories. The conduct and findings of that study contributed significantly to the conduct of this study; however, literature reported in the Gourley study will not be repeated here.

TOPICS REQUIRED IN ENGINEERING TECHNOLOGY PROGRAMS

In order to achieve the objectives of the study it was necessary to identify the educational topics required of engineering technology graduates for the programs under study. Selection of items for the inventory required a review of literature on topics required in engineering technology programs. This review helped in determining which topics to include, the statements to use in describing the topics, the headings to use in grouping topics, the rating scales to use, and the overall organization of the inventory to simplify both the responses and the compiling of data. It also gave an indication of what responses to expect on the topic inventory.

The numerous curriculum guides and course outlines for engineering technology programs available from the North Carolina Department of Community Colleges (various dates) were reviewed and considered carefully in compiling the inventory. The broadly representative advisory committee input in the development of these curriculum materials gave significant credibility to their content.

The National Institute for Certification of Engineering Technologies (various dates) has available a variety of "technician's orientation to certification" manuals and "program detail manuals." These manuals listed work elements for four levels of certification in a variety of engineering technology job classifications, primarily in civil and electrical/electronic fields. These manuals were reviewed and topics having application for the program areas under study were identified.

Brodsky, (1983) identified those areas of concern most frequently cited as deficient by the Technology Accreditation Commission (TAC) of the Accreditation Board for Engineering and Technology (ABET) in final visitation reports of engineering technology institutions. While this article did not specifically address topics required in engineering technology programs, it did identify areas in the program that reflected the need for administrative leadership. The factors most frequently cited were: (1) lack of computer applications in technical courses, (2) laboratory equipment problems, (3) some subject or course needed, (4) too few faculty for the program, (5) inadequate professional activity or faculty development program, (6) some faculty without proper degrees, (7) laboratory space problems, and (8) teaching work load too heavy. The most frequently cited factors relating to faculty described a pattern of understaffing, inadequate institutional attention to the professional growth of faculty, and unsatisfactory incentive in recruiting properly qualified faculty.

Wells, Caldwell, and Arthur (1985) reported on a summer workshop on Manufacturing Engineering Technology education sponsored by the Manufacturing Engineering Education Foundation of the Society of Manufacturing Engineers (SME) and the OMI College of Applied Science of the University of Cincinnati, in cooperation with the Manufacturing Division of the American Society for Engineering Education (ASEE). Included in the report was a listing of minimum instructional content to be included in associate degree programs in Manufacturing Engineering Technology.

The Center for Occupational Research and Development (1985), as a part of their high technology series published an advanced technology core curriculum guide with a common core curriculum for engineering technology programs. Program topics were identified with course outlines that included suggested laboratory experiences, student competencies, suggested texts, and references.

The Accreditation Board for Engineering and Technology, Inc. (ABET) (1985) identified major curriculum elements for engineering technology programs, along with criteria for accrediting programs.

Course outlines for engineering technology courses at Central Piedmont Community College (1986) were updated in preparation for an ABET visit in the fall during which this study was being prepared. Copies of these content outlines provided information on major topics in selected ABET accredited programs in North Carolina.

SUMMARY OF THE REVIEW OF LITERATURE

In the literature on topics required of engineering technology graduates, factors most frequently cited by ABET visiting teams in engineering technology institutions as failing to meet accreditation standards included: lack of computer applications in technical courses, laboratory equipment problems, and some subject or course needed.

Numerous engineering technology curriculum guides and course outlines were available that had been developed for use in North Carolina community college institutions. Also, program materials were available that had been developed at the national level, both for Manufacturing Engineering Technology programs and for advanced technology programs in the curriculum areas under study. In addition, a review was conducted of work elements required for the certification of engineering technicians at the national level.

The work of two research studies had a direct impact on the design of this study and the inventory used. One identified the basic science and mathematics topics most needed by graduates of six engineering technology programs in a North Carolina community college institution. The other included a comprehensive review of literature on competency inventories and reported on the design and use of a self-assessment inventory developed with the assistance of a national panel of experts. A variety of statistical procedures were used by these studies to analyze inventory items.

CHAPTER III

STUDY METHODOLOGY

The primary purpose of this study was to identify the essential educational topics, and the level of proficiency perceived to be required in these topics, for selected engineering technology programs offered in North Carolina community college institutions.

The investigator sought answers to the following questions: (1) What educational topics are perceived to be needed currently for engineering technology graduates from each of the four programs studied; (2) What are the levels of proficiency required in classwork and laboratory for these engineering technology programs; (3) Are there any differences in the opinions of graduates, employers, and instructors concerning what should be in these programs; and (4) Which of the educational topics are common to more than one of the technologies being studied? To answer these questions, a descriptive study was undertaken using a self-report research approach. A mailed questionnaire was used to collect information from a sample of graduates, employers, and instructors in engineering technology programs in North Carolina (including those that are ABET accredited,) and from instructors in ABET accredited two-year programs throughout the United States.

ORGANIZATIONAL PLAN AND PROCEDURE

The study was divided into the following phases: (1) review of literature, (2) development of the survey instrument, (3) administration of the survey instrument, (4) collection of data, (5) treatment of data, (6) analysis of data, and (7) preparation of the report. Literature was reviewed pertaining to the identification of educational topics for engineering technology programs. A questionnaire was developed and sent to 133 graduates, 130 employers, 52 North Carolina instructors, and 80 out-of-state instructors. They were requested to provide responses to 108 topics and 6 background information questions. Data were collected in May 1987. One-hundred-and-seventy-eight individuals returned usable questionnaires for a 45% return from the population surveyed. The number of questionnaires returned by subgroups of respondents was: graduates, 48; employers, 49; NC instructors, 39; and out-of-state instructors, 42. The compilation of this data allowed statistics to be computed for each of the 108 topic items as well as the 6 background items. The following sections provide additional information about the activities undertaken in the study phases.

DEVELOPMENT OF THE TOPIC INVENTORY

The questionnaire used in this study was specifically designed for the study by the researcher to achieve the objectives of the study. Topics used in the inventory were gleaned from several sources and modified to maintain a common format. (See Appendix B.) Resources used in developing the inventory included the work of Edwards and Roberson (1979); The Center for Occupational Research and Development (1985);

National Institute for the Certification of Engineering Technologies (variable dates); North Carolina Department of Community Colleges (variable dates); Central Piedmont Community College (1986); and Wells, Caldwell, and Arthur (1986). Broad areas of knowledge or skill were identified as topics (or components) and these topics were organized using the general headings used by ABET. (See Appendix C.) The first draft of the inventory was developed with input of the Department of Community Colleges staff and reviewed by a state and national review panel. This panel of fourteen individuals included seven engineering technology administrators from across the United States, five from North Carolina and two individuals with special backgrounds related to the study. (See Appendix D.) Major modifications were made to the inventory based on suggestions made by the committee. The revisions on the inventory were incorporated into the questionnaire and the revised instrument was then submitted back to this group and to the Department of Community Colleges staff for response. Again, revisions were made to the inventory based upon the comments of the review panel. This version of the questionnaire was further revised with the assistance of the Department of Community Colleges staff. After the final changes were made, the questionnaire was prepared with a cover letter for dissemination to the study population.

ADMINISTRATION OF THE INVENTORY

The population studied was graduates, employers, and instructors of engineering technology programs in North Carolina and instructors in ABET accredited two-year engineering technology programs throughout the United States. All North Carolina institutions offering one or more of the four engineering technology programs studied were contacted and requested to provide the names of five graduates from the program, five employers of graduates from the program, and one faculty member in the program. (See Appendix E.) There were 27 North Carolina institutions with one or more engineering technology programs for a total of 43 programs -- 8 Mechanical Engineering Technology, 21 Mechanical Drafting and Design Technology, 7 Manufacturing Engineering Technology, and 7 Industrial Engineering Technology programs. (See Appendix F.) Of these 43 engineering technology programs in North Carolina institutions the following number were ABET accredited: Mechanical Engineering Technology, 3; Mechanical Drafting and Design Technology, 2; Manufacturing Engineering Technology, 2; Industrial Engineering Technology, 3. In addition, all ABET accredited programs in these four categories in states other than North Carolina were identified. (See Appendix G.) From this list, institutions were selected to be surveyed for Mechanical Engineering Technology (49), Mechanical Drafting and Design (15), Manufacturing Engineering Technology (7), and Industrial Engineering Technology (9). Criteria used in selecting these programs included: total number of ABET-accredited programs, date of program accreditation, size of institution, number of ABET-accredited programs in the institution, and geographic distribution. The questionnaire was sent out on April 15, 1987, and included a letter of introduction (See Appendixes H and I) and a return-addressed, stamped envelope.

COLLECTION OF DATA

Due to the timing of the project it was critical that there be an inducement for individuals to respond to the questionnaire. Administrators of engineering technology programs in North Carolina were alerted to the study at the quarterly statewide meeting of instructional administrators in April, 1987 and the inventory was sent to the instructors which they designated. For out-of-state instructors it was indicated that a summary of the findings would be presented at the Annual Conference of ASEE, which was to be held in the middle of June. There was no inducement provided for the graduates and employers contacted. Also, there were no follow-up efforts with any subgroup.

A total of 201 returns were received, of which 178 were usable for a 45% return from the 395 which were mailed out. (See Appendix J for a listing of institutions represented by the respondents.) The twenty-three responses not used included 12 returned because of insufficient address, six returned after the final cut-off date of June 1, 1987 when analysis of data had already begun, four with a curriculum response of "other," and one returned blank, with an indication that the respondent was not the appropriate person to complete the form. The number of usable returns from subgroups of the population is shown in Table 3A.

Table 3A. Response to the Survey Questionnaire, by Group*

Group	Total Number in Group	Number Returning Survey	Percentage
Graduates	133	48	36%
Employers	130	49	38%
North Carolina Instructors	52	39	75%
Instructors in Other States	80	42	53%
Total	395	178	45%
Mechanical Engineering Technology	110	57	52%
Mechanical Drafting and Design Technology	181	69	38%
Manufacturing Engineering Technology	49	28	57%
Industrial Engineering Technology	55	24	44%
Total	395	178	45%

*Note: For Response by Subgroup, See Appendix K.

TREATMENT OF DATA

The data collected from the returned questionnaires were entered into a computer file by the Information Management Section of the North Carolina Department of Community Colleges. In addition to verification by the data entry personnel, the Department of Community Colleges staff double checked the initial printout against every original survey instrument to ensure that each return was accurately transcribed. Corrections were made to the data file for errors noted. Programming assistance and computing capabilities of the North Carolina Department of Community Colleges' Management Information Section were provided in the data treatment phase. SAS statistical analysis programs were used to manipulate the data. Analyses run on the data included frequencies and factor analysis. Statistics were computed on the inventory items for both the "classwork" and "laboratory" responses.

Frequencies were compiled from the responses to each topic by each respondent subgroup and for each curriculum. These frequencies were used to determine which topics should be included at what level in which curriculums. Factor analysis was run on the "classwork" and "laboratory" responses for each curriculum and items identified by the factor analysis that met certain criteria of frequency response (and were not already included) were added to the list of "essential" topics.

SUMMARY OF THE STUDY METHODOLOGY

The study used a mailed questionnaire to gather responses to a 108 item topic inventory and 6 background information questions. The inventory was drafted using the survey of literature to provide an initial list of topics and then refined with the assistance of a state and national panel of experts.

The questionnaire was sent to 395 graduates, employers, and instructors of engineering technology programs. One-hundred-and-seventy-eight usable responses were received for a 45% response rate. Data collected from the questionnaire were subjected to statistical analysis using SAS statistical analysis programs. Analyses run on the data included frequencies and factor analysis. Comparisons were computed for educational topics required by curriculum among the subgroups of respondents.

The findings from these procedures are reported in Chapter IV.

CHAPTER IV

PRESENTATION AND INTERPRETATION OF FINDINGS

This study sought to identify the esential educational topics, and the level of proficiency perceived to be required in these topics, for selected two-year engineering technology education programs offered in North Carolina Community Colleges institutions. A 108 item topic inventory was used to collect data for analysis. The primary descriptive statistics computed were frequencies and factor analysis. The findings for the study are presented in the following order: (1) a listing by program of the levels of proficiency required in classroom and laboratory for "essential" topics as well as the differences in the opinions of graduates, employers, and instructors concerning what should be in the programs; and (2) a comparison, among the four programs studied, of the educational topics and proficiency levels perceived to be needed by graduates.

A brief discussion of the findings is given at the end of each section. A summary of the findings is provided at the end of the chapter.

INFORMATION PROVIDED ON THE PROGRAMS

Information has been prepared from the data for each of the four individual programs - Mechanical Engineering Technology, Mechanical Drafting and Design Technology, Manufacturing Engineering Technology and Industrial Engineering Technology. "Essential" topics are listed and the level of proficiency perceived to be required is identified for each topic. In addition, the major differences in the responses of graduates, employers, and instructors regarding the level of proficiency perceived to be required are provided by topic for each program. Tables provide a listing of "essential" topics, levels of proficiency, and differences in response for each curriculum for both classwork and laboratory.

LEVELS OF PROFICIENCY REQUIRED OF ENGINEERING TECHNOLOGY GRADUATES

The frequencies for each proficiency level, by classwork and laboratory, were used to determine the perceived level of proficiency required for each topic in each curriculum. For each topic, the proficiency level receiving the highest percentage of overall response was identified as the proficiency level "required." There were four levels of proficiency identified from which to respond for both classwork and laboratory.

For classwork, these were:
1) in-depth study - thorough knowledge (3)
2) general coverage - basic concepts (2)
3) limited exposure - orientation (1)
4) no exposure none needed (0).

For laboratory, these were:
1) skilled - no supervision needed (3)
2) moderately skilled - limited supervision (2)
3) limited skills - close supervision (1)
4) no exposure - none needed (0).

For most topics, there was one proficiency level receiving the highest frequency of response. In the few cases where there was a tie for the highest percentage response, frequencies in adjacent levels were used to help make the determination.

TOPICS ESSENTIAL FOR ENGINEERING TECHNOLOGY GRADUATES

The frequencies of response were also used to help determine "essential" topics. For each of the proficiency levels (0, 1, 2, 3) perceived to be required in classwork and laboratory, if the total percentage of respondents choosing levels two (2) and three (3) - "general coverage (2)" and "in-depth study (3)" for classwork and "moderate skill (2)" and "high skill (3)" for laboratory - was greater than 65%, the topic was identified as an "essential" topic.

In addition to frequencies of response, the factor analysis was used to help confirm topics considered to be "essential" to each curriculum. The factor analysis technique was used to group into a "general factor" those topics which were responded to similarly (should be in the program). This grouping was compared with the frequency responses for those topics identified as essential. In addition to the topics already identified using frequency response, any topics identified in the "general factor" listing that received a frequency response of 50% or greater (in proficiency levels two and three) were included as topics perceived to be essential in the curriculum. Use of the factor analysis generally reinforced the findings based on the frequency response.

DIFFERENCES IN THE RESPONSES OF GRADUATES, EMPLOYERS, AND INSTRUCTORS

Responses of each of the four subgroups - employers, graduates, national instructors, and North Carolina instructors - were compared with the overall response for each curriculum. The responses of individual subgroups differed from the overall response on some of the topics in the inventory. If the majority of one subgroup rated a particular topic higher (by two response levels) than the overall group response, it was marked "H" under the appropriate column; if lower by two response levels, it was marked with an "L". The four subgroups are employers (E), graduates (G), instructors in two-year programs that are ABET accredited in states other than North Carolina (N), and instructors in North Carolina two-year engineering technology programs (including those that are ABET accredited) (NC).

STUDY FINDINGS - MECHANICAL ENGINEERING TECHNOLOGY

There were a total of 110 questionnaires sent to employers, graduates, and instructors identified with the Mechanical Engineering Technology program. Of these, 57 (52%) returned usable responses. There were 11 employers, 12 graduates, 24 national instructors, and 10 North Carolina instructors who returned the survey. Their responses were grouped for all analyses, except for the comparison of differences in response by subgroup.

Of the 108 topics used in the study, 57 (53%) classwork and 41 (38%) laboratory topics were identified as essential for the Mechanical Engineering Technology program. Of the 57 classwork topics, 20 were determined to require "in-depth study (3)" and 37 "general coverage (2)." Of the 41 laboratory topics, 13 were determined to require "high skill (3)" and 28 required a "moderate skill (2)" level. (See Table 4A.) The use of factor analysis resulted in three of the 57 classwork topics and five of the laboratory topics being included in the list of essential topics. (See Table 4B.) All items identified by factor analysis were determined to require a "general coverage (2)/moderate skill (2)" level of proficiency.

North Carolina instructors ranked two essential classwork topics lower than the overall group. National instructors ranked three laboratory topics lower, and North Carolina instructors ranked one laboratory topic lower, than the overall group. (See Table 4C.)

ESSENTIAL TOPICS AND LEVELS OF PROFICIENCY REQUIRED FOR MECHANICAL ENGINEERING TECHNOLOGY

Topics in the Mechanical Engineering Technology curriculum that are perceived to require both "in-depth study (3)" in classwork and "high skill (3)" in laboratory are blueprint reading, technical drafting fundamentals, strength of materials, computer basics, machine design, arithmetic, algebra, geometry, trigonometry, grammar/spelling/composition, oral communications, and technical report writing. Topics perceived to require "general coverage (2)" in classwork and "moderate skill (2)" in laboratory are drafting-small mechanical systems, descriptive geometry, computer aided drafting, machine metalworking processes, manufacturing processes, metrology, engineering materials-metallic, fluid mechanics, fluid power, electrical fundamentals, applied thermodymanics & heat transfer, microcomputer usage, programming languages, computer workstation usage, computer aided design, engineering applications for computer, software applications program usage, physics-electrical, physics-fluids, physics-heat, physics-light, physics-sound, and analytical geometry. Topics requiring "in-depth study (3)" in classwork, but "moderate skill (2)" in laboratory are mechanical devices and systems, engineering materials testing, mechanisms, and physics-mechanics. Topics requiring "in-depth study (3)" in classwork, and no laboratory are statics, dynamics, metric units and conversions and technical writing. Topics requiring "general coverage (2)" in classwork, and no laboratory are destructive examination techniques, control system fundamentals, pneumatic instrumentation, hydraulic instrumentation, physical metallurgy, engineering materials-non-metallic, jig and fixture design, chemistry, differential calculus, integral calculus, conference communications, and introduction to technology. One topic required laboratory, but not classwork - electrical devices.

SUMMARY BY TOPICAL CATEGORY OF THE MECHANICAL ENGINEERING TECHNOLOGY FINDINGS

For the Mechanical Engineering Technology program, 57 classwork and 41 laboratory topics were identified as essential. In the Technical Skills & Techniques category, 15 of the 48 topics listed were identified as essential for the Mechanical Engineering Technology curriculum. Fourteen of these topics were perceived to require classwork and eleven laboratory. A number of Mathematics and Communications topics required "high skill" in laboratory in addition to "in-depth study" in classwork. All of the Computer Usage topics were required at some level in both classwork and laboratory. In the Basic Sciences category, all physics topics, except one, were required in both classwork and laboratory, and chemistry was required in classwork. Mathematics topics, through integral calculus, were perceived to be required. Most of the topics

(82%) in the categories other than Technical Skills & Techniques and Social Science/Humanities were required in classwork and/or laboratory. One of the nine Social Science/Humanities topics was identified as essential.

TABLE 4A

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	 Laboratory
I.	**TECHNICAL SKILLS AND TECHNIQUES**		
A.	BLUEPRINT READING	3	3
B.	TECHNICAL DRAFTING FUNDAMENTALS	3	3
C.	DRAFTING - MECHANICAL COMPONENTS	2	3
D.	DRAFTING - SMALL MECHANICAL SYSTEMS	2	2
E.	DESCRIPTIVE GEOMETRY	2	2
F.	COMPUTER AIDED DRAFTING	2	2
G.	MACHINE METALWORKING PROCESSES	2	2
H.	MANUFACTURING PROCESSES	2	2
I.	DESTRUCTIVE EXAMINATION TECHNIQUES	2	
J.	METROLOGY	2	2
K.	CONTROL SYSTEM FUNDAMENTALS	2	
L.	PNEUMATIC INSTRUMENTATION	2	
M.	HYDRAULIC INSTRUMENTATION	2	
N.	ELECTRICAL DEVICES		2
O.	MECHANICAL DEVICES AND SYSTEMS	3	2
II.	**TECHNICAL SCIENCES**		
A.	STATICS	3	
B.	DYNAMICS	3	
C.	STRENGTH OF MATERIALS	3	3

TABLE 4A

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

MECHANICAL ENGINEERING TECHNOLOGY

		Proficiency Levels	
ITEM #	ESSENTIAL TOPICS	Classwork	Laboratory
D.	ENGINEERING MATERIALS TESTING	3	2
E.	PHYSICAL METALLURGY	2	
F.	ENGINEERING MATERIALS - METALLIC	2	2
G.	ENGINEERING MATERIALS - NON-METALLIC	2	
H.	FLUID MECHANICS	2	2
I.	FLUID POWER	2	2
J.	ELECTRICAL FUNDAMENTALS	2	2
K.	APPLIED THERMODYNAMICS AND HEAT TRANSFER	2	2
III.	**COMPUTER USAGE**		
A.	COMPUTER BASICS	3	3
B.	MICROCOMPUTER USAGE	2	2
C.	PROGRAMMING LANGUAGES	2	2
D.	COMPUTER WORKSTATION USAGE	2	2
E.	COMPUTER AIDED DESIGN	2	2
F.	ENGINEERING APPLICATIONS FOR COMPUTERS	2	2
G.	SOFTWARE APPLICATIONS PROGRAM USAGE	2	2
IV.	**TECHNICAL DESIGN**		
A.	MECHANISMS	3	2
B.	MACHINE DESIGN	3	3
C.	JIG AND FIXTURE DESIGN	2	
D.	COMPUTER AIDED DESIGN	2	2

TABLE 4A

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Laboratory
V.	**BASIC SCIENCES**		
A.	PHYSICS - MECHANICS	3	2
B.	PHYSICS - ELECTRICAL	2	2
C.	PHYSICS - FLUIDS	2	2
D.	PHYSICS - HEAT	2	2
E.	PHYSICS - LIGHT	2	2
F.	PHYSICS - SOUND	2	2
G.	CHEMISTRY	2	
VI.	**MATHEMATICS**		
A.	ARITHMETIC	3	3
B.	ALGEBRA	3	3
C.	GEOMETRY	3	3
D.	TRIGONOMETRY	3	3
E.	ANALYTICAL GEOMETRY	2	2
F.	DIFFERENTIAL CALCULUS	2	
G.	INTEGRAL CALCULUS	2	
H.	METRIC UNITS AND CONVERSIONS	3	

TABLE 4A

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
VII.	**COMMUNICATIONS**		
A.	GRAMMAR, SPELLING AND COMPOSITION	3	3
B.	ORAL COMMUNICATIONS	3	3
C.	TECHNICAL WRITING	3	
D.	TECHNICAL REPORT WRITING	3	3
E.	CONFERENCE COMMUNICATIONS	2	
VIII.	**SOCIAL SCIENCE/HUMANITIES**		
A.	INTRODUCTION TO TECHNOLOGY	2	

TABLE 4B

TOPICS IDENTIFIED BY FACTOR ANALYSIS AS ESSENTIAL:

MECHANICAL ENGINEERING TECHNOLOGY*

TOPICS	PROFICIENCY LEVEL REQUIRED	PERCENT RESPONSE**
CLASSWORK		
Destructive Examination Techniques	2	54.37
Chemistry	2	62.96
Introduction to Technology	2	53.70
LABORATORY		
Manufacturing Processes	2	58.93
Metrology	2	60.72
Electrical Devices	2	50.87
Applied Thermodynamics and Heat Transfer	2	55.36
Physics-Sound	2	61.11

* These items met the criteria for an essential topic based on factor analysis, but did not meet the criteria based on frequency of response.

** Less than 65%, but greater than 50%, of responses were a "2" or "3" on PROFICIENCY LEVEL REQUIRED

TABLE 4C

DIFFERENCES IN OPINIONS HELD BY SUBGROUPS CONCERNING TOPICS THAT SHOULD BE IN MECHANICAL ENGINEERING TECHNOLOGY

	DIFFERENCES AMONG SUBGROUP RESPONSES (H-Higher; L-Lower)							
	CLASSWORK				LABORATORY			
	E	G	N	NC	E	G	N	NC
Technical Skills and Techniques								
Manufacturing Processes								L
Basic Sciences								
Chemistry				L				
Mathematics								
Arithmetic							L	
Analytical Geometry							L	
Communications								
Oral Communications							L	
Social Science/Humanities								
Introduction to Technology				L				

KEY:
E - Employer
G - Graduate
N - National Instructors
NC - North Carolina Instructors

STUDY FINDINGS - MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

There were a total of 181 questionnaires sent to employers, graduates, and instructors identified with the Mechanical Drafting and Design Technology program. Of these, 69 (38%) provided usable responses. There were 23 employers, 25 graduates, 7 national instructors, and 14 North Carolina instructors who returned the survey. The results of their responses were grouped for all analyses, except for the comparison of differences in response by subgroup.

Of the 108 topics used in the study, 44 (41%) classwork and 26 (24%) laboratory topics were identified as essential for the Mechanical Drafting and Design Technology program. Of the 44 classwork topics, 24 were determined to require "in-depth study" and 20 "general coverage." Of the 26 laboratory topics, 15 were determined to require "high skill" and 11 moderate skill." (See Table 4D.) The use of factor analysis resulted in two of the 44 classwork topics and four of the laboratory topics being included in the list of essential topics. All items identified by factor analysis were determined to require a "general coverage/moderate skill" level of proficiency. (See Table 4E.)

National instructors ranked one essential classwork topic lower than the overall group. National instructors ranked five laboratory topics lower, and North Carolina instructors ranked one laboratory topic lower, than the overall group. (See Table 4F.)

ESSENTIAL TOPICS AND LEVELS OF PROFICIENCY REQUIRED FOR MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

Topics in the Mechanical Drafting and Design Technology curriculum that are perceived to require both "in-depth study (3)" in classwork and "high skill (3)" in laboratory are blueprint reading, technical drafting fundamentals, drafting-mechanical components, computer aided drafting, computer aided design, mechanisms, arithmetic, algebra, geometry, trigonometry, grammar/spelling/composition, and oral communications. Topics perceived to require "general coverage (2)" in classwork and "moderate skill (2) in laboratory are drafting-small mechanical systems, machine metalworking processes, fluid mechanics, jig and fixture design, and tool and die design. Topics requiring "in-depth study (3)" in classwork, but "moderate skill (2)" in laboratory are descriptive geometry, strength of materials, physics-mechanics, metric units and conversions, technical writing, and technical report writing. Machine design required "general coverage (2)" in classwork and "high skill (3)" in laboratory. Topics requiring "in-depth study (3)" in classwork, and no laboratory are statics, computer basics, microcomputer usage, computer workstation usage, and analytical geometry. Topics requiring "general coverage (2)" in classwork, but no laboratory are NC/CNC machining processes, manufacturing processes, mechanical devices and systems, engineering materials testing, physical metallurgy, engineering materials-metallic, engineering materials-nonmetallic, fluid power, engineering applications for computer, physics-electrical, physics-fluids, physics-heat, conference communications, and industrial relations.

SUMMARY BY TOPICAL CATEGORY OF THE MECHANICAL DRAFTING AND DESIGN TECHNOLOGY FINDINGS

In the Mechanical Drafting and Design Technology, only 44 classwork and 26 laboratory topics were identified as essential. These were the lowest percentage responses of any program in the study. In the Technical Skills & Techniques category, 10 of the 48 topics were identified as essential. Drafting topics were the primary emphasis in this category. Computer aided drafting was perceived to require "in-depth study" in classwork and "high skill" in laboratory. Machine metalworking processes, NC/CNC machine processes, manufacturing processes, and mechanical devices and systems were the other topics identified as essential. Of the 13 Technical Sciences topics, classwork was perceived to be required for eight and laboratory for two. Classwork was required for five of the seven Computer Usage topics and laboratory for one. Five of the six topics in Technical Design were required in both classwork and laboratory. In the Basic Science category, classwork was required for four physics topics and laboratory for one. Mathematics topics through analytical geometry (six of eleven topics) were identified as essential. All topics in the Communications category were required in classwork and all but one was required in laboratory. One of the nine Social Science/Humanities topics was identified as essential.

TABLE 4D

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
I.	**TECHNICAL SKILLS AND TECHNIQUES**		
A.	BLUEPRINT READING	3	3
B.	TECHNICAL DRAFTING FUNDAMENTALS	3	3
C.	DRAFTING - MECHANICAL COMPONENTS	3	3
D.	DRAFTING - SMALL MECHANICAL SYSTEMS	2	2
E.	DESCRIPTIVE GEOMETRY	3	2
F.	COMPUTER AIDED DRAFTING	3	3
G.	MACHINE METALWORKING PROCESSES	2	2
H.	NC/CNC MACHINE PROCESSES	2	
I.	MANUFACTURING PROCESSES	2	
J.	MECHANICAL DEVICES AND SYSTEMS		2
II.	**TECHNICAL SCIENCES**		
A.	STATICS	3	
B.	STRENGTH OF MATERIALS	3	2
C.	ENGINEERING MATERIALS TESTING	2	
D.	PHYSICAL METALLURGY	2	
E.	ENGINEERING MATERIALS - METALLIC	2	
F.	ENGINEERING MATERIALS - NON-METALLIC	2	
G.	FLUID MECHANICS	2	2
H.	FLUID POWER	2	

TABLE 4D

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
III.	**COMPUTER USAGE**		
A.	COMPUTER BASICS	3	
B.	MICROCOMPUTER USAGE	3	
C.	COMPUTER WORKSTATION USAGE	3	
D.	COMPUTER AIDED DESIGN	3	3
E.	ENGINEERING APPLICATIONS FOR COMPUTERS	2	
IV.	**TECHNICAL DESIGN**		
A.	MECHANISMS	3	3
B.	MACHINE DESIGN	2	3
C.	JIG AND FIXTURE DESIGN	2	2
D.	TOOL AND DIE DESIGN	2	2
E.	COMPUTER AIDED DESIGN	3	3
V.	**BASIC SCIENCES**		
A.	PHYSICS - MECHANICS	3	2
B.	PHYSICS - ELECTRICAL	2	
C.	PHYSICS - FLUIDS	2	
D.	PHYSICS - HEAT	2	

TABLE 4D

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
VI.	**MATHEMATICS**		
A.	ARITHMETIC	3	3
B.	ALGEBRA	3	3
C.	GEOMETRY	3	3
D.	TRIGONOMETRY	3	3
E.	ANALYTICAL GEOMETRY	3	
F.	METRIC UNITS AND CONVERSIONS	3	2
VII.	**COMMUNICATIONS**		
A.	GRAMMAR, SPELLING AND COMPOSITION	3	3
B.	ORAL COMMUNICATIONS	3	3
C.	TECHNICAL WRITING	3	2
D.	TECHNICAL REPORT WRITING	3	2
E.	CONFERENCE COMMUNICATIONS	3	
VIII.	**SOCIAL SCIENCE/HUMANITIES**		
A.	INDUSTRIAL RELATIONS	2	

TABLE 4E

TOPICS IDENTIFIED BY FACTOR ANALYSIS AS ESSENTIAL: MECHANICAL DRAFTING AND DESIGN TECHNOLOGY*

TOPIC	PROFICIENCY LEVEL REQUIRED	PERCENT RESPONSE**
CLASSWORK		
NC/CNC Machine Processes	2	54.41
Industrial Relations	2	53.73
LABORATORY		
Machine Metalworking Processes	2	59.70
Jig and Fixture Design	2	59.42
Tool and Die Design	2	59.42

* These items met the criteria for an essential topic based on factor analysis, but did not meet the criteria based on frequency of response.

** Less than 65%, but greater than 50%, of responses were a "2" or "3" on PROFICIENCY LEVEL REQUIRED

TABLE 4F

DIFFERENCES IN OPINIONS HELD BY SUBGROUPS CONCERNING TOPICS THAT SHOULD BE IN MECHANICAL DRAFTING AND DESIGN TECHNOLOGY

	CLASSWORK				LABORATORY			
	E	G	N	NC	E	G	N	NC
Technical Sciences								
Fluid Mechanics			L				L	
Communications								
Grammar, Spelling and Composition							L	
Oral Communications							L	
Technical Writing							L	
Conference Communications							L	L

KEY:
E - Employer
G - Graduate
N - National Instructors
NC - North Carolina Instructors

STUDY FINDINGS - MANUFACTURING ENGINEERING TECHNOLOGY

There were a total of 49 questionnaires sent to employers, graduates, and instructors identified with the Manufacturing Engineering Technology program. Of these, 28 (57%) provided usable responses. There were 8 employers, 3 graduates, 7 national instructors, 9 North Carolina instructors, and one "other" respondent who returned the survey. The results of their responses were grouped for all analyses, except the comparison of differences in response by subgroup.

Of the 108 topics used in the study, 84 (77%) classwork and 55 (51%) laboratory topics were identified as essential for the Manufacturing Engineering Technology program. Of the 84 classwork topics, 27 were determined to require "in-depth study" and 57 "general coverage." (See Table 4G.) Of the 55 laboratory topics, 19 were determined to require "high skill" and 36 "moderate skill." The use of factor analysis resulted in five of the 84 classwork topics and eight of the laboratory topics being included in the list of essential topics. All items identified by factor analysis were determined to required a "general coverage/moderate skill" level of proficiency. (See Table 4H.)

Employers ranked one essential classwork topic and one laboratory topic lower than the overall group. National instructors ranked seven laboratory topics lower than the overall group. (See Table 4I.)

ESSENTIAL TOPICS AND LEVELS OF PROFICIENCY REQUIRED FOR MANUFACTURING ENGINEERING TECHNOLOGY

Topics in the Manufacturing Engineering Technology curriculum that are perceived to require both "in-depth study (3)" in classwork and "high skill (3)" in laboratory are blueprint reading, technical drafting fundamentals, drafting-mechanical components, drafting-small mechanical systems, manufacturing processes, quality control, engineering materials testing, computer basics, microcomputer usage, jig and fixture design, plant layout, arithmetic, algebra, geometry, trigonometry, and oral communications. Topics perceived to require "general coverage (2)" in classwork and "moderate skill (2)" in laboratory are descriptive geometry, plastic machining processes, NC/CNC machining processes, material handling/processing/assembling methods, computer aided manufacturing, automated systems, robotics, control system fundamentals, electronic instrumentation, pneumatic instrumentation, hydraulic instrumentation, electrical devices, electromechanical devices, industrial electricity, electronic devices and systems, industrial electronics, mechanical devices and systems, strength of materials, physical metallurgy, electrical fundamentals, electronic principles, programming languages, computer aided design, engineering applications for computer, tool and die design, physics-electrical, physics-fluids, physics-heat, physics-sound, chemistry, and differential calculus.

Topics requiring "in-depth study (3)" in classwork, but "moderate skill (2)" in laboratory are machine metalworking processes, engineering materials-metallic, fluid power, and physics-mechanics. Topics requiring "general coverage (2)" in classwork, but "high skill (3)" in laboratory are computer aided drafting, metrology, and computer workstation usage. Topics requiring "in-depth study (3)" in classwork, but no laboratory are industrial safety, methods improvement, metric units and conversions, grammar/spelling/composition, technical writing, and technical report writing. Topics requiring "general coverage (2)" in classwork, but no laboratory are nondestructive examination techniques, destructive examination techniques, lubrication, industrial organization and management, quality assurance practices, statistical process control, finance/accounting/economic analysis, production methods, production planning, inventory management, statics, dynamics, engineering materials non-metallic, software applications program usage, mechanisms, machine design, analytical geometry, integral calculus, statistics, conference communications, introduction to technology, economics in technology, applied psychology, and industrial relations. No topics are required in laboratory, that do not require classwork.

SUMMARY BY TOPICAL CATEGORY OF THE MANUFACTURING ENGINEERING TECHNOLOGY FINDINGS

Responses to the Manufacturing Engineering Technology curriculum indicated a strong need for the topics identified on the survey instrument. Of the 108 topics, 84 classwork and 55 laboratory topics were identified as essential. In the Technical Skills & Techniques category, 38 of the 48 topics were identified as essential. Of these 38 topics, 26 were perceived to require both classwork and laboratory. Those requiring only classwork were primarily topics traditionally identified with Industrial Engineering Technology. In the Technical Sciences category, 10 topics were required in classwork and seven in laboratory. All seven of the Computer Usage topics were identified as essential in classwork and six of the seven were identified as essential in laboratory. Mathematics topics - through integral calculus and statistics were identified as essential. All Communications topics were identified as essential in classwork, but only one was identified as essential in laboratory. Overall, most of the topics (84%) in the categories other than Technical Skills & Techniques and Social Science/Humanities were required in classwork and/or laboratory. Four of the nine Social Science/Humanities topics were identified as essential.

TABLE 4G

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MANUFACTURING ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
I.	**TECHNICAL SKILLS AND TECHNIQUES**		
A.	BLUEPRINT READING	3	3
B.	TECHNICAL DRAFTING FUNDAMENTALS	3	3
C.	DRAFTING - MECHANICAL COMPONENTS	3	3
D.	DRAFTING - SMALL MECHANICAL SYSTEMS	3	3
E.	DESCRIPTIVE GEOMETRY	2	2
F.	COMPUTER AIDED DRAFTING	2	3
G.	MACHINE METALWORKING PROCESSES	3	2
H.	PLASTIC MACHINING PROCESSES	2	2
I.	NC/CNC MACHINE PROCESSES	2	2
J.	MANUFACTURING PROCESSES	3	3
K.	NONDESTRUCTIVE EXAMINATION (NDE) TECHNIQUES	2	
L.	DESTRUCTIVE EXAMINATION TECHNIQUES	2	
M.	METROLOGY	2	3
N.	MATERIAL HANDLING, PROCESSING AND ASSEMBLING METHODS	2	2
O.	COMPUTER AIDED MANUFACTURING	2	2
P.	AUTOMATED SYSTEMS	2	2
Q.	ROBOTICS	2	2
R.	CONTROL SYSTEM FUNDAMENTALS	2	2
S.	ELECTRONIC INSTRUMENTATION	2	2
T.	PNEUMATIC INSTRUMENTATION	2	2

TABLE 4G

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

MANUFACTURING ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels	
		Classwork	Laboratory
U.	HYDRAULIC INSTRUMENTATION	2	2
V.	ELECTRICAL DEVICES	2	2
W.	ELECTROMECHANICAL DEVICES	2	2
X.	INDUSTRIAL ELECTRICITY	2	2
Y.	ELECTRONIC DEVICES AND SYSTEMS	2	2
Z.	INDUSTRIAL ELECTRONICS	2	2
AA.	MECHANICAL DEVICES AND SYSTEMS	2	2
AB.	LUBRICATION	2	
AC.	INDUSTRIAL SAFETY	3	
AD.	INDUSTRIAL ORGANIZATION AND MANAGEMENT	2	
AE.	QUALITY CONTROL	3	3
AF.	QUALITY ASSURANCE PRACTICES	2	
AG.	STATISTICAL PROCESS CONTROL	2	
AH.	METHODS IMPROVEMENT	3	
AI.	FINANCE, ACCOUNTING AND ECONOMIC ANALYSIS	2	
AJ.	PRODUCTION METHODS	2	
AK.	PRODUCTION PLANNING	2	
AL.	INVENTORY MANAGEMENT	2	
II.	**TECHNICAL SCIENCES**		
A.	STATICS	2	
B.	DYNAMICS	2	
C.	STRENGTH OF MATERIALS	2	2

TABLE 4G

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

MANUFACTURING ENGINEERING TECHNOLOGY

		Proficiency Levels	
ITEM #	ESSENTIAL TOPICS	Classwork	Laboratory
D.	ENGINEERING MATERIALS TESTING	3	3
E.	PHYSICAL METALLURGY	2	2
F.	ENGINEERING MATERIALS - METALLIC	3	2
G.	ENGINEERING MATERIALS - NON-METALLIC	2	
H.	FLUID POWER	3	2
I.	ELECTRICAL FUNDAMENTALS	2	2
J.	ELECTRONIC PRINCIPLES	2	2
III.	**COMPUTER USAGE**		
A.	COMPUTER BASICS	3	3
B.	MICROCOMPUTER USAGE	3	3
C.	PROGRAMMING LANGUAGES	2	2
D.	COMPUTER WORKSTATION USAGE	2	3
E.	COMPUTER AIDED DESIGN	2	2
F.	ENGINEERING APPLICATIONS FOR COMPUTERS	2	2
G.	SOFTWARE APPLICATIONS PROGRAM USAGE	2	
IV.	**TECHNICAL DESIGN**		
A.	MECHANISMS	2	
B.	MACHINE DESIGN	2	
C.	JIG AND FIXTURE DESIGN	3	3
D.	TOOL AND DIE DESIGN	2	2
E.	COMPUTER AIDED DESIGN	2	2
F.	PLANT LAYOUT	3	3

TABLE 4G

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MANUFACTURING ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
V.	**BASIC SCIENCES**		
A.	PHYSICS - MECHANICS	3	2
B.	PHYSICS - ELECTRICAL	2	2
C.	PHYSICS - FLUIDS	2	2
D.	PHYSICS - HEAT	2	2
E.	PHYSICS - SOUND	2	2
F.	CHEMISTRY	2	2
VI.	**MATHEMATICS**		
A.	ARITHMETIC	3	3
B.	ALGEBRA	3	3
C.	GEOMETRY	3	3
D.	TRIGONOMETRY	3	3
E.	ANALYTICAL GEOMETRY	2	
F.	DIFFERENTIAL CALCULUS	2	2
G.	INTEGRAL CALCULUS	2	
H.	STATISTICS	2	
I.	METRIC UNITS AND CONVERSIONS	3	

TABLE 4G

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: MANUFACTURING ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Laboratory
VII.	**COMMUNICATIONS**		
A.	GRAMMAR, SPELLING AND COMPOSITION	3	
B.	ORAL COMMUNICATIONS	3	3
C.	TECHNICAL WRITING	3	
D.	TECHNICAL REPORT WRITING	3	
E.	CONFERENCE COMMUNICATIONS	2	
VIII.	**SOCIAL SCIENCE/HUMANITIES**		
A.	INTRODUCTION TO TECHNOLOGY	2	
B.	ECONOMICS IN TECHNOLOGY	2	
C.	APPLIED PSYCHOLOGY	2	
D.	INDUSTRIAL RELATIONS	2	

TABLE 4H

TOPICS IDENTIFIED BY FACTOR ANALYSIS AS ESSENTIAL: MANUFACTURING ENGINEERING TECHNOLOGY*

TOPICS	PROFICIENCY LEVEL REQUIRED	PERCENT RESPONSE **
CLASSWORK		
Nondestructive Examination (NDE) Technology	2	57.14
Lubrication	2	57.14
Inventory Management	2	53.58
Differential Calculus	2	64.28
Integral Calculus	2	50.00
LABORATORY		
Electronic Instrumentation	2	52.00
Electrical Devices	2	59.25
Industrial Electricity	2	61.54
Electronic Devices and Systems	2	57.69
Industrial Electronics	2	62.50
Electronic Principles	2	63.64

* These items met the criteria for an essential topic based on factor analysis, but did not meet the criteria based on frequency of response.

** Less than 65%, but greater than 50%, of responses were a "2" or "3" on PROFICIENCY LEVEL REQUIRED

TABLE 4I

DIFFERENCES IN OPINIONS HELD BY SUBGROUPS CONCERNING TOPICS THAT SHOULD BE IN MANUFACTURING ENGINEERING TECHNOLOGY

	DIFFERENCES AMONG SUBGROUP RESPONSES (H-Higher; L-Lower)							
	CLASSWORK				LABORATORY			
	E	G	N	NC	E	G	N	NC
Technical Skills								
Plastic Machining Processes					L			
Technical Sciences								
Fluid Power	L							
Technical Design								
Plant Layout							L	
Mathematics								
Arithmetic							L	
Algebra							L	
Geometry							L	
Trigonometry							L	
Differential Calculus							L	
Communications								
Oral Communications							L	

KEY:
E - Employer
G - Graduate
N - National Instructors
NC - North Carolina Instructors

STUDY FINDINGS - INDUSTRIAL ENGINEERING TECHNOLOGY

There were a total of 55 questionnaires sent to employers, graduates, and instructors identified with the Industrial Engineering Technology program. Of these, 24 (44%) provided usable responses. There were 5 employers, 8 graduates, 4 national instructors, 6 North Carolina instructors, and one respondent classified as "other" who returned the survey. The results of their responses were grouped for all analyses except the comparison of differences in response by subgroup.

Of the 108 topics used in the study, 63 (58%) classwork and 30 (28%) laboratory topics were identified as essential for the Industrial Engineering Technology program. Of the 63 classwork topics, 27 were determined to require "in-depth study" and 36 "general coverage." (See Table 4J.) Of the 30 laboratory topics, 15 were determined to require "high skill" and 15 "moderate skill." The use of factor analysis resulted in five of the 63 classwork topics and eleven of the laboratory topics being included in the list of essential topics. All items identified by factor analysis were determined to require a "general coverage/moderate skill" level of proficiency, except (1) Production Methods and (2) Grammar, Spelling & Composition - which required high skill in laboratory. (See Table 4K.)

Employers and national instructors ranked two essential classwork topics lower than the overall group. Graduates ranked six laboratory topics lower, and national instructors ranked one laboratory topic lower, than the overall group. (See Table 4L.)

ESSENTIAL TOPICS AND LEVELS OF PROFICIENCY REQUIRED FOR INDUSTRIAL ENGINEERING TECHNOLOGY

Topics in the Industrial Engineering Technology curriculum that are perceived to require both "in-depth study (3)" in classwork and "high skill (3)" in laboratory are manufacturing processes, material handling/processing/assembling methods, quality assurance practices, methods improvement, production methods, microcomputer usage, jig and fixture design, plant layout, arithmetic, algebra, grammar/spelling/composition, oral communications, technical writing, and technical report writing. Topics perceived to require "general coverage (2)" in classwork and "moderate skill (2)" in laboratory are blueprint reading, technical drafting fundamentals, computer aided drafting, computer aided manufacturing, finance/accounting/economic analysis, manufacturing cycles, computer aided design, engineering applications for computer, and statistics. Topics requiring "in-depth study (3)" in classwork, but "moderate skill (2)" in laboratory are job analysis and evaluation, industrial supervision, computer basics, software applications program usage, and conference communications. Only one topic required "general coverage (2)" in classwork, but "high skill (3)" in laboratory - statistical process control. Topics requiring "in-depth study (3)" in classwork, but no laboratory are industrial organization and management, quality control, production planning, geometry, trigonometry, analytical geometry, metric units and conversions, and industrial relations. Topics requiring "general coverage (2)" in classwork, but no laboratory are machine metalworking processes, plastic machining processes, NC/CNC machining processes, metrology, automated systems, robotics, control system fundamentals, control system design, industrial safety, codes and standards, inventory management, electrical fundamentals, programming languages, computer workstation usage, physics-mechanics, physics-electrical, physics-fluids, physics-heat, physics-light, physics-sound, basic digital mathematics, introduction to technology, economics in technology, applied psychology, and social science. No topics required laboratory and no classwork.

SUMMARY OF THE INDUSTRIAL ENGINEERING TECHNOLOGY FINDINGS

Of the 108 topics on the survey instrument, 63 classwork and 30 laboratory topics were identified as essential. In the Technical Skills & Techniques category, 28 of the 48 topics were identified as essential. Of these 28, 14 were perceived to require both classwork and laboratory. Only one Technical Sciences topic was identified as essential - electrical fundamentals - and that was in classwork only. All the Computer Usage topics were identified as essential in classwork and five of the seven were identified as essential in laboratory. Three of the six Technical Design topics were identified as essential in both classwork and laboratory. Six physics topics in the Basic Sciences category were identified as essential in classwork, but none were identified as essential in laboratory. Mathematics topics - through analytic geometry, basic digital mathematics, and statistics - were identified as essential. All Communications topics were identified as essential in both classwork and laboratory. Five of the nine Social Science/Humanities topics were identified as essential.

TABLE 4J

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

INDUSTRIAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Laboratory
I.	**TECHNICAL SKILLS AND TECHNIQUES**		
A.	BLUEPRINT READING	2	2
B.	TECHNICAL DRAFTING FUNDAMENTALS	2	2
C.	COMPUTER AIDED DRAFTING	2	2
D.	MACHINE METALWORKING PROCESSES	2	
E.	PLASTIC MACHINING PROCESSES	2	
F.	NC/CNC MACHINE PROCESSES	2	
G.	MANUFACTURING PROCESSES	3	3
H.	METROLOGY	2	
I.	MATERIAL HANDLING, PROCESSING AND ASSEMBLING METHODS	3	3
J.	COMPUTER AIDED MANUFACTURING	2	2
K.	AUTOMATED SYSTEMS	2	
L.	ROBOTICS	2	
M.	CONTROL SYSTEM FUNDAMENTALS	2	
N.	CONTROL SYSTEM DESIGN	2	
O.	INDUSTRIAL SAFETY	2	
P.	INDUSTRIAL ORGANIZATION AND MANAGEMENT	3	
Q.	QUALITY CONTROL	3	
R.	QUALITY ASSURANCE PRACTICES	3	3
S.	STATISTICAL PROCESS CONTROL	2	3
T.	METHODS IMPROVEMENT	3	3
U.	JOB ANALYSIS AND EVALUATION	3	2

TABLE 4J

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

INDUSTRIAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Proficiency Levels Laboratory
V.	INDUSTRIAL SUPERVISION	3	2
W.	FINANCE, ACCOUNTING AND ECONOMIC ANALYSIS	2	2
X.	MANUFACTURING CYCLES	2	2
Y.	PRODUCTION METHODS	3	3
Z.	PRODUCTION PLANNING	3	
AA.	CODES AND STANDARDS	2	
AB.	INVENTORY MANAGEMENT	2	
II.	**TECHNICAL SCIENCES**		
A.	ELECTRICAL FUNDAMENTALS	2	
III.	**COMPUTER USAGE**		
A.	COMPUTER BASICS	3	2
B.	MICROCOMPUTER USAGE	3	3
C.	PROGRAMMING LANGUAGES	2	
D.	COMPUTER WORKSTATION USAGE	2	
E.	COMPUTER AIDED DESIGN	2	2
F.	ENGINEERING APPLICATIONS FOR COMPUTERS	2	2
G.	SOFTWARE APPLICATIONS PROGRAM USAGE	3	2

TABLE 4J

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS:

INDUSTRIAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	 Laboratory
IV.	**TECHNICAL DESIGN**		
A.	JIG AND FIXTURE DESIGN	3	3
B.	COMPUTER AIDED DESIGN	2	2
C.	PLANT LAYOUT	3	3
V.	**BASIC SCIENCES**		
A.	PHYSICS - MECHANICS	2	
B.	PHYSICS - ELECTRICAL	2	
C.	PHYSICS - FLUIDS	2	
D.	PHYSICS - HEAT	2	
E.	PHYSICS - LIGHT	2	
F.	PHYSICS - SOUND	2	
VI.	**MATHEMATICS**		
A.	ARITHMETIC	3	3
B.	ALGEBRA	3	3
C.	GEOMETRY	3	
D.	TRIGONOMETRY	3	
E.	ANALYTICAL GEOMETRY	3	
F.	BASIC DIGITAL MATHEMATICS	2	
G.	STATISTICS	2	2
H.	METRIC UNITS AND CONVERSIONS	3	

TABLE 4J

PROFICIENCY LEVELS IDENTIFIED FOR ESSENTIAL CLASSWORK AND LABORATORY TOPICS: INDUSTRIAL ENGINEERING TECHNOLOGY

ITEM #	ESSENTIAL TOPICS	Proficiency Levels Classwork	Laboratory
VII.	**COMMUNICATIONS**		
A.	GRAMMAR, SPELLING AND COMPOSITION	3	3
B.	ORAL COMMUNICATIONS	3	3
C.	TECHNICAL WRITING	3	3
D.	TECHNICAL REPORT WRITING	3	3
E.	CONFERENCE COMMUNICATIONS	3	2
VIII.	**SOCIAL SCIENCE/HUMANITIES**		
A.	INTRODUCTION TO TECHNOLOGY	2	
B.	ECONOMICS IN TECHNOLOGY	2	
C.	APPLIED PSYCHOLOGY	2	
D.	SOCIAL SCIENCE	2	
E.	INDUSTRIAL RELATIONS	3	

TABLE 4K

TOPICS IDENTIFIED BY FACTOR ANALYSIS AS ESSENTIAL: INDUSTRIAL ENGINEERING TECHNOLOGY*

TOPICS	PROFICIENCY LEVEL REQUIRED	PERCENT RESPONSE**
CLASSWORK		
Computer Aided Drafting	2	61.00
Plastic Machine Processes	2	62.50
Metrology	2	50.00
Introduction to Technology	2	50.00
Social Sciences	2	62.50
LABORATORY		
Computer Aided Drafting	2	56.50
Computer Aided Manufacturing	2	62.50
Industrial Supervision	2	62.50
Finance, Accounting & Economic Analysis	2	50.00
Manufacturing Cycles	2	58.34
Production Methods	3	62.50
Software Applications Program Usage	2	58.34
Statistics	2	62.50
Grammar, Spelling & Composition	3	62.50
Conference Communications	2	52.17

* These items met the criteria for an essential topic based on factor analysis, but did not meet the criteria based on frequency of response.

** Less than 65%, but greater than 50%, of responses were a "2" or "3" on PROFICIENCY LEVEL REQUIRED

TABLE 4L

DIFFERENCES IN OPINIONS HELD BY SUBGROUPS CONCERNING TOPICS THAT SHOULD BE IN INDUSTRIAL ENGINEERING TECHNOLOGY

	DIFFERENCES AMONG SUBGROUP RESPONSES (H-Higher; L-Lower)							
	CLASSWORK				LABORATORY			
TOPICS	E	G	N	NC	E	G	N	NC
Technical Skills and Techniques								
Computer Aided Drafting						L		
Control System Design			L					
Quality Assurance Practices	L							
Finance, Accounting & Econ. Anal.							L	
Manufacturing Cycles						L		
Mathematics								
Analytical Geometry	L							
Communications								
Grammar, Spelling and Composition						L		
Technical Writing						L		
Technical Report Writing						L		
Conference Communications						L		
Social Science/Humanities								
Introduction to Technology			L					

KEY:
E - Employer
G - Graduate
N - National Instructors
NC - North Carolina Instructors

COMMON TOPICS IN THE FOUR PROGRAMS STUDIED

ESSENTIAL TOPICS BY CURRICULUM

By comparing topics in the four curriculums studied, those topics essential to each curriculum were identified and the level of proficiency required for each essential topic, as perceived by the respondents, was determined. Analysis of essential topics in each curriculum reveals the number of classwork topics varying from 44 for Mechanical Drafting and Design Technology to 84 for Manufacturing Engineering Technology. The number of essential laboratory topics varied from 26 for Mechanical Drafting and Design Technology to 55 for Manufacturing Engineering Technology. (See Table 4M for a listing of essential topics identified by frequency of response and by commonality of response (factor analysis).) (Note: Topics used in this study do not relate directly to courses or credit hours. They identify broad areas of knowledge and/or skill involved in the preparation of individuals for employment. Because of this, several topics might possibly be combined into one course, or one topic might be covered in several courses, depending on the level of proficiency required and other related factors.)

TABLE 4M

NUMBER OF ESSENTIAL TOPICS BY CURRICULUM

(IDENTIFIED BY FREQUENCY AND BY FACTOR ANALYSIS)

(Total Number of Topics = 108)

CURRICULUM	NUMBER OF ESSENTIAL TOPICS FREQUENCY	FACTOR ANALYSIS	TOTAL
CLASSWORK			
Mechanical Engineering Technology	54	3	57
Mechanical Drafting & Design Technology	42	2	44
Manufacturing Engineering Technology	79	5	84
Industrial Engineering Technology	58	5	63
LABORATORY			
Mechanical Engineering Technology	36	5	41
Mechanical Drafting & Design Technology	22	4	26
Manufacturing Engineering Technology	47	8	55
Industrial Engineering Technology	19	11	30

PROFICIENCY LEVELS REQUIRED FOR ESSENTIAL TOPICS BY CURRICULUM

The number of essential classwork topics requiring "in-depth study (3)" varied from 20 for Mechanical Engineering Technology to 27 for Manufacturing Engineering Technology and Industrial Engineering Technology. The number of essential classwork topics requiring "general coverage (2)" varied from 20 for Mechanical Drafting and Design Technology to 57 for Manufacturing Engineering Technology.

The number of essential laboratory topics requiring "high skill (3)" varied from 13 for Mechanical Engineering Technology to 19 for Manufacturing Engineering Technology. The number of essential laboratory topics requiring "moderate skill (2)" varied from 11 for Mechanical Drafting and Design Technology to 36 for Manufacturing Engineering Technology. (See Table 4N.)

TABLE 4N

NUMBER OF ESSENTIAL TOPICS IN EACH PROFICIENCY LEVEL BY CURRICULUM

	PROFICIENCY LEVEL CLASSWORK		PROFICIENCY LEVEL LABORATORY	
	3*	2*	3*	2*
Mechanical Engineering Technology	20	37	13	28
Mechanical Drafting & Design Technology	24	20	15	11
Manufacturing Engineering Technology	27	57	19	36
Industrial Engineering Technology	27	36	15	15

*PROFICIENCY LEVELS

Classwork

2-General Coverage - Basic Concepts
3-In-depth Study - Thorough Knowledge

Laboratory

2-Moderately Skilled - Limited Supervision
3-(Highly) Skilled - No Supervision Needed

VARIATIONS IN ESSENTIAL TOPICS AND LEVELS OF PROFICIENCY REQUIRED

A summary table (Table 40) is provided as an overview of the level of proficiency required for each essential topic by curriculum.

For classwork, the two levels of proficiency identified for essential topics were 1) in-depth study - thorough knowledge (3) and 2) general coverage - basic concepts (2). For laboratory, the two levels were: 1) skilled - no supervision needed (3) and 2) moderately skilled limited supervision (2).

Many topics in each curriculum were rated as essential for both classwork and laboratory. Some topics, however, received different ratings between classwork and laboratory. For example, the response by Mechanical Engineering Technology respondents to Control System Fundamentals indicated that classwork was essential and laboratory was not. The summary table (Table 40) lists proficiency levels required for essential topics by classwork and laboratory for each of the four curriculums under study.

Most topics in each curriculum received equal ratings of proficiency levels required for both classroom and laboratory. In some cases, however, there was a difference between the proficiency level required in classwork and laboratory. For example, in Mechanical Engineering Technology, Drafting Mechanical components showed a need for "general coverage - basic concepts (2)" in classwork, but "high skill - no supervision needed (3)" in laboratory.

Combined, these ratings can be used to give a more complete picture of the relationship between curriculums. For example, the response to Computer Aided Drafting indicates that Mechanical Drafting and Design Technology graduates need "in-depth study" in classwork while graduates of the other three curriculums need a "general coverage." In laboratory for this topic, Mechanical Drafting and Design Technology and Manufacturing Engineering Technology graduates need "high skill," while Mechanical Engineering Technology and Industrial Engineering Technology graduates need "moderate skill."

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

		PROFICIENCY LEVELS REQUIRED							
		CLASSWORK				LABORATORY			
ITEM #	TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
I.	**TECHNICAL SKILLS AND TECHNIQUES**								
A.	BLUEPRINT READING	3	3	3	2	3	3	3	2
B.	TECHNICAL DRAFTING FUNDAMENTALS	3	3	3	2	3	3	3	2
C.	DRAFTING - MECHANICAL COMPONENTS	2	3	3		3	3	3	
D.	DRAFTING - SMALL MECHANICAL SYSTEMS	2	2	3		2	2	3	
E.	DESCRIPTIVE GEOMETRY	2	3	2		2	2	2	
F.	COMPUTER AIDED DRAFTING	2	3	2	2	2	3	3	2
G.	MACHINE METALWORKING PROCESSES	2	2	3	2	2	2	2	
H.	PLASTIC MACHINING PROCESSES			2	2			2	
I.	NC/CNC MACHINE PROCESSES		2	2	2	2		2	
J.	MANUFACTURING PROCESSES	2	2	3	3	2		3	3
K.	NONDESTRUCTIVE EXAMINATION (NDE) TECHNIQUES			2					
L.	DESTRUCTIVE EXAMINATION TECHNIQUES	2		2					
M.	METROLOGY	2		2	2	2		3	
N.	MATERIAL HANDLING, PROCESSING AND ASSEMBLING METHODS			2	3			2	3
O.	COMPUTER AIDED MANUFACTURING			2	2			2	2
P.	AUTOMATED SYSTEMS			2	2			2	
Q.	ROBOTICS			2	2			2	
R.	CONTROL SYSTEM FUNDAMENTALS	2		2	2			2	

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

		PROFICIENCY LEVELS REQUIRED							
		CLASSWORK				LABORATORY			
ITEM #	TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
S.	CONTROL SYSTEM DESIGN				2				
T.	ELECTRONIC INSTRUMENTATION			2				2	
U.	PNEUMATIC INSTRUMENTATION	2		2				2	
V.	HYDRAULIC INSTRUMENTATION	2		2				2	
W.	HEATING SYSTEM DESIGN								
X.	AIR CONDITIONING SYSTEM DESIGN								
Y.	REFRIGERATION SYSTEM DESIGN								
Z.	ELECTRICAL DEVICES			2		2		2	
AA.	ELECTROMECHANICAL DEVICES			2				2	
AB.	INDUSTRIAL ELECTRICITY			2				2	
AC.	CIRCUIT ANALYSIS								
AD.	ELECTRONIC DEVICES AND SYSTEMS			2				2	
AE.	INDUSTRIAL ELECTRONICS			2				2	
AF.	MECHANICAL DEVICES AND SYSTEMS	3	2	2		2		2	
AG.	MACHINE CARE/MAINTENANCE								
AH.	LUBRICATION			2					
AI.	INDUSTRIAL SAFETY			3	2				
AJ.	INDUSTRIAL ORGANIZATION AND MANAGEMENT			2	3				
AK.	QUALITY CONTROL			3	3			3	
AL.	QUALITY ASSURANCE PRACTICES			2	3				3
AM.	STATISTICAL PROCESS CONTROL			2	2				3

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

		PROFICIENCY LEVELS REQUIRED							
		CLASSWORK				LABORATORY			
ITEM #	TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
AN.	METHODS IMPROVEMENT			3	3				3
AO.	JOB ANALYSIS AND EVALUATION				3				2
AP.	INDUSTRIAL SUPERVISION				3				2
AQ.	FINANCE, ACCOUNTING AND ECONOMIC ANALYSIS			2	2				2
AR.	MANUFACTURING CYCLES				2				2
AS.	PRODUCTION METHODS			2	3				3
AT.	PRODUCTION PLANNING			2	3				
AU.	CODES AND STANDARDS				2				
AV.	INVENTORY MANAGEMENT			2	2				
II.	**TECHNICAL SCIENCES**								
A.	STATICS	3	3	2					
B.	DYNAMICS	3		2					
C.	STRENGTH OF MATERIALS	3	3	2		3	2	2	
D.	ENGINEERING MATERIALS TESTING	3	2	3		2		3	
E.	PHYSICAL METALLURGY	2	2	2				2	
F.	ENGINEERING MATERIALS - METALLIC	2	2	3		2		2	
G.	ENGINEERING MATERIALS - NON-METALLIC	2	2	2					
H.	FLUID MECHANICS	2	2			2	2		
I.	FLUID POWER	2	2	3		2		2	

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

		PROFICIENCY LEVELS REQUIRED							
		CLASSWORK				LABORATORY			
ITEM #	TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
J.	ELECTRICAL FUNDAMENTALS	2		2	2	2		2	
K.	CIRCUIT ANALYSIS								
L.	ELECTRONIC PRINCIPLES			2				2	
M.	APPLIED THERMODYNAMICS AND HEAT TRANSFER	2				2			
III.	**COMPUTER USAGE**								
A.	COMPUTER BASICS	3	3	3	3	3	3	3	2
B.	MICROCOMPUTER USAGE	2	3	3	3	2		3	3
C.	PROGRAMMING LANGUAGES	2		2	2	2		2	
D.	COMPUTER WORKSTATION USAGE	2	3	2	2	2		3	
E.	COMPUTER AIDED DESIGN	2	3	2	2	2	3	2	2
F.	ENG. APPLICATIONS FOR COMPUTERS	2	2	2	2	2		2	2
G.	SOFTWARE APPLICATIONS PROGRAM USAGE	2		2	3	2			2
IV.	**TECHNICAL DESIGN**								
A.	MECHANISMS	3	3	2		2	3		
B.	MACHINE DESIGN	3	2	2		3	3		
C.	JIG AND FIXTURE DESIGN	2	2	3	3		2	3	3
D.	TOOL AND DIE DESIGN		2	2			2	2	
E.	COMPUTER AIDED DESIGN	2	3	2	2	2	3	2	2
F.	PLANT LAYOUT			3	3			3	3

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

	PROFICIENCY LEVELS REQUIRED							
	CLASSWORK				LABORATORY			
ITEM # TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
V. BASIC SCIENCES								
A. PHYSICS - MECHANICS	3	3	3	2	2	2	2	
B. PHYSICS - ELECTRICAL	2	2	2	2	2		2	
C. PHYSICS - FLUIDS	2	2	2	2	2		2	
D. PHYSICS - HEAT	2	2	2	2	2		2	
E. PHYSICS - LIGHT	2			2	2			
F. PHYSICS - SOUND	2		2	2	2		2	
G. PHYSICS - ATOMIC								
H. CHEMISTRY	2		2				2	
I. LIFE SCIENCE								
VI. MATHEMATICS								
A. ARITHMETIC	3	3	3	3	3	3	3	3
B. ALGEBRA	3	3	3	3	3	3	3	3
C. GEOMETRY	3	3	3	3	3	3	3	
D. TRIGONOMETRY	3	3	3	3	3	3	3	
E. ANALYTICAL GEOMETRY	2	3	2	3	2			
F. DIFFERENTIAL CALCULUS	2		2				2	
G. INTEGRAL CALCULUS	2		2					
H. DIFFERENTIAL EQUATIONS								

TABLE 40
COMPARATIVE OVERVIEW OF LEVELS OF PROFICIENCY REQUIRED FOR "ESSENTIAL" TOPICS IN MECHANICAL ENGINEERING TECHNOLOGY (MET), MECHANICAL DRAFTING AND DESIGN TECHNOLOGY (MDT), MANUFACTURING ENGINEERING TECHNOLOGY (MFG), AND INDUSTRIAL ENGINEERING TECHNOLOGY (IET)

		PROFICIENCY LEVELS REQUIRED							
		CLASSWORK				LABORATORY			
ITEM #	TOPIC	MET	MDT	MFG	IET	MET	MDT	MFG	IET
I.	BASIC DIGITAL MATHEMATICS				2				
J.	STATISTICS			2	2				2
K.	METRIC UNITS AND CONVERSIONS	3	3	3	3		2		
VII.	**COMMUNICATIONS**								
A.	GRAMMAR, SPELLING AND COMPOSITION	3	3	3	3	3	3		3
B.	ORAL COMMUNICATIONS	3	3	3	3	3	3	3	3
C.	TECHNICAL WRITING	3	3	3	3		2		3
D.	TECHNICAL REPORT WRITING	3	3	3	3	3	2		3
E.	CONFERENCE COMMUNICATIONS	2	2	2	3				2
VIII.	**SOCIAL SCIENCE/HUMANITIES**								
A.	INTRODUCTION TO TECHNOLOGY	2		2	2				
B.	ECONOMICS IN TECHNOLOGY				2				
C.	APPLIED PSYCHOLOGY			2	2				
D.	SOCIAL SCIENCE				2				
E.	INDUSTRIAL RELATIONS		2	2	3				
F.	PHILOSOPHY								
G.	LITERATURE								
H.	MUSIC								
I.	ART								

ESSENTIAL TOPICS BY TOPICAL CATEGORY

Eight categories were used to group topics for this study. These categories were based on the curriculum element categories used by the Accreditation Board for Engineering and Technology (ABET). The headings for the eight categories are Technical Skills & Techniques, Technical Sciences, Computer Usage, Technical Design, Basic Sciences, Mathematics, Communications, and Social Science/Humanities.

Response to topics within these categories varied depending on the curriculum. For example, the number of topics identified as essential in either classwork and/or laboratory in the Technical Skills & Techniques category varied from 38 for Manufacturing Engineering Technology to 10 for Mechanical Drafting and Design Technology. Likewise, in the Technical Sciences category Mechanical Engineering Technology identified 11 as essential and Industrial Engineering Technology only one. On the other hand, in Communications all curriculums identified all topics as essential in classwork and/or laboratory. See Table 4P for additional information on this breakdown. Also, a more detailed discussion of each topical category follows.

TABLE 4P

NUMBER OF ESSENTIAL TOPICS BY TOPICAL CATEGORY AND CURRICULUM

	Number of Topics Identified as Essential in Classwork and/or Laboratory				
	MET	MDT	MFG	IET	TOTAL
Technical Skills and Techniques	15	10	38	28	48
Technical Science	11	8	10	1	13
Computer Usage	7	5	7	7	7
Technical Design	4	5	6	3	6
Basic Science	7	4	6	6	9
Mathematics	8	6	9	8	11
Communications	5	5	5	5	5
Social Science/Humanities	1	1	4	5	9

Technical Skills & Techniques - Classwork

The Technical Skills & Techniques category is the area in which there is the greatest diversity of topics between curriculums. Of the forty-eight topics listed in this category, five are essential in all four curriculums, seven are essential in three curriculums, eighteen in two curriculums, and thirteen are essential in only one curriculum. Topics in this category that were listed in all four curriculums as essential are blueprint reading, technical drafting fundamentals, computer aided drafting, machine metalworking processes, and manufacturing processes. Topics that were essential in three curriculums - the Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology - are drafting-mechanical components, drafting-small mechanical systems, descriptive geometry, and mechanical devices & systems. Other topics that were essential in three curriculums - Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology - are metrology and control system fundamentals. One topic was essential in Mechanical Drafting and Design Technology, Manufacturing Engineering Technology and Industrial Engineering Technology - NC/CNC machine processes. Topics that were identified as essential in two curriculums Manufacturing Engineering Technology and Industrial Engineering Technology are plastic machining processes, materials handling/processing/assembly methods, computer aided manufacturing, automated systems, robotics, industrial safety, industrial organization & management, quality control, quality assurance practices, statistical process control, methods improvement, finance/accounting/economic analysis, production methods, production planning, and inventory management. Topics essential in Mechanical Engineering Technology and Manufacturing Engineering Technology were destructive examination techniques, pneumatic instrumentation, and hydraulic instrumentation. Topics essential in only one curriculum - Manufacturing Engineering Technology - were nondestructive examination techniques, electronic instrumentation, electrical devices, electromechanical devices, industrial electricity, electronic devices & systems, industrial electronics and lubrication. Other topics essential in only one curriculum Industrial Engineering Technology - were control system design, job analysis & evaluation, industrial supervision, manufacturing cycles, and codes and standards.

Technical Skills and Techniques - Laboratory

Essential topics required in laboratory for all four curriculums were blueprint reading, technical drafting fundamentals, and computer aided drafting. Four topics were required in three curriculums - Mechanical Engineering Technology, Mechanical Drafting and Design Technology, Manufacturing Engineering Technology - drafting-mechanical components, drafting-small mechanical systems, descriptive geometry, and machine metalworking processes. One topic, manufacturing processes, was required in three other curriculums - Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Three topics were required in Mechanical Engineering Technology and Manufacturing Engineering Technology - NC/CNC machine processes, electrical devices, and mechanical devices & systems. Two topics were required in both Manufacturing Engineering Technology and Industrial Engineering Technology materials handling/processing/

assembling methods and computer aided manufacturing. Thirteen topics were required only in Manufacturing Engineering Technology and eight topics were required only in Industrial Engineering Technology.

Technical Sciences - Classwork

No topics were identified as being essential in all four curriculums. Seven topics were identified as being essential for three curriculums Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology. These were statics, strength of materials, engineering materials testing, physical metallurgy, engineering materials-metallic, engineering materials-non-metallic, and fluid power. One topic, electrical fundamentals, was also required in three curriculums Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Two topics were required in separate sets of two curriculums each: 1) dynamics was considered to be essential in Mechanical Engineering Technology and Manufacturing Engineering Technology and 2) fluid mechanics was considered essential in Mechanical Engineering Technology and Mechanical Drafting and Design Technology. In addition, electronic principles was considered essential in Manufacturing Engineering Technology and applied thermodynamics & heat transfer was considered essential in Mechanical Engineering Technology.

Technical Sciences - Laboratory

Again, no topics were considered to be essential in laboratory for all four curriculums. One topic, strength of materials, was "essential" in Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology. Engineering materials testing, engineering materials-metallic, fluid power, and electrical fundamentals were essential in both Mechanical Engineering Technology and Manufacturing Engineering Technology. Fluid mechanics was essential in both Mechanical Engineering Technology and Mechanical Drafting and Design Technology. Physical metallurgy and electronics principles were essential in Manufacturing Engineering Technology, and applied thermodynamics & heat transfer was essential in Mechanical Engineering Technology.

Computer Usage - Classwork

Five of the seven topics listed for computers were required in all four curriculums - computer basics, microcomputer usage, computer workstation usage, computer aided design, and engineering applications for computer. The other two topics, programming languages and software applications program usage, were required in three curriculums - Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology.

Computer Usage - Laboratory

Two topics, computer basics and computer aided design, were essential in laboratory in all four curriculums. Microcomputer usage and engineering applications for computers were considered essential in Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Programming languages was considered "essential" in Mechanical Engineering Technology and Manufacturing Engineering Technology and software applications program usage was essential in Mechanical Engineering Technology and Industrial Engineering Technology. Computer workstation usage was essential in Manufacturing Engineering Technology.

Technical Design - Classwork

Two topics were essential in all four curriculums - jig & fixture design and computer aided design. Two topics, mechanisms and machine design, were considered essential in three curriculums - Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology. Tool & die design was essential in Mechanical Drafting and Design Technology and Manufacturing Engineering Technology. Plant layout was essential in Manufacturing Engineering Technology and Industrial Engineering Technology.

Technical Design - Laboratory

Computer aided design was considered essential in all four curriculums. Jig & fixture design was essential in Mechanical Drafting and Design Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Mechanisms and machine design were essential in Mechanical Engineering Technology and Mechanical Drafting and Design Technology. Tool & die design was essential in Mechanical Drafting and Design Technology and Manufacturing Engineering Technology. Plant layout was essential in Manufacturing Engineering Technology and Industrial Engineering Technology.

Basic Sciences - Classwork

Four physics topics - mechanics, electrical, fluids, and heat - were considered essential in all four curriculums. Physics-sound was considered essential in Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Physics-light was considered essential in Mechanical Engineering Technology and Industrial Engineering Technology, and chemistry was considered essential in Mechanical Engineering Technology and Manufacturing Engineering Technology.

Basics Sciences - Laboratory

One topic, physics-mechanics, was considered an essential laboratory in three curriculums - Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology. Four physics topics - electrical, fluids, heat, and sound - were considered essential in Mechanical Engineering Technology and Manufacturing Engineering Technology. Physics-light was essential in Mechanical Engineering Technology and chemistry was essential in Manufacturing Engineering Technology.

Mathematics - Classwork

Six topics - arithmetic, algebra, geometry, trigonometry, analytical geometry, and metric units & conversions - were considered essential in all four curriculums. Differential calculus and integral calculus were considered essential in Mechanical Engineering Technology and Manufacturing Engineering Technology. Statistics was essential in Manufacturing Engineering Technology and Industrial Engineering Technology. Basic digital mathematics was essential in Industrial Engineering Technology.

Mathematics - Laboratory

Laboratories in two topics, arithmetic and algebra, were considered essential in all four curriculums. Geometry and trigonometry laboratories were considered essential in Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Manufacturing Engineering Technology. Analytical geometry was considered essential in Mechanical Engineering Technology, differential calculus in Manufacturing Engineering Technology, statistics in Industrial Engineering Technology, and metric units & conversions in Mechanical Drafting and Design Technology.

Communications - Classwork

All five topics - grammar/spelling/composition, oral communications, technical writing, technical report writing, and conference communications were considered essential in all four curriculums.

Communications - Laboratory

Laboratory in oral communications was considered essential in all four curriculums. Grammar/spelling/composition and technical report writing were considered essential in Mechanical Engineering Technology, Mechanical Drafting and Design Technology, and Industrial Engineering Technology. Technical writing was essential in Mechanical Drafting and Design Technology and Industrial Engineering Technology. Conference communication was essential in Industrial Engineering Technology.

Social Science/Humanities - Classwork

Introduction to technology was considered essential in Mechanical Engineering Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology and industrial relations was essential in Mechanical Drafting and Design Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology. Economics in technology and applied psychology were considered essential in Manufacturing Engineering Technology and Industrial Engineering Technology. Social science was considered essential in Industrial Engineering Technology.

Social Science/Humanities - Laboratory

No topics were considered essential in any curriculums for laboratory in the social sciences or humanities.

SUMMARY OF COMMON TOPICS IN THE FOUR PROGRAMS STUDIED

From a review of the responses to the questionnaire it can be determined that each of the four curriculums studied is a unique, identifiable curriculum that requires a number of different topics from the others. Also for many topics considered to be essential, different levels of proficiency are required for different curriculums. Tables give the number of essential topics and the proficiency level of each topic for each curriculum.

The composite picture of essential topics and levels of proficiency can be used to present a comprehensive picture of topics that are perceived to be needed in each curriculum. Comparisons can be made of the variations for those topics needed in more than one curriculum. A comprehensive summary of this information would be quite extensive. Since readers may wish to draw their own conclusions, only a brief overview has been provided here.

It is in the Technical Skills & Techniques category that one finds the major differences between these four programs. The Manufacturing Engineering Technology program required the highest levels of proficiency and the most subjects, and the Mechanical Drafting and Design Technology required the lowest levels of proficiency and the least number of subjects. Differences in levels of proficiency required for these topics between curriculums suggests that courses covering these topics should be either individually tailored for each curriculum and/or designed so that they can be presented to develop multiple levels of proficiency, according to the curriculum in which the topic is being offered.

In the Technical Sciences category three of the four curriculums identified almost all classwork topics as essential and two curriculums identified seven of the 13 laboratory topics as essential. The Industrial Engineering Technology identified only one subject as essential. There was some difference in level of proficiency required between curriculums for the Technical Sciences category.

In the Computer Usage category all curriculums identified almost all of the topics listed as essential and requiring about the same levels of proficiency among curriculums. Most topics in this category were considered essential in laboratory as well as in classwork.

For the Technical Design category, about the same levels of proficiency were perceived to be required among curriculums for those topics identified as essential.

For the Basic Sciences category most essential topics required a "general coverage (2)/moderate skill (2)" level of proficiency. For laboratory the Mechanical Drafting and Design Technology and Industrial Engineering Technology curriculums identified only a few topics as essential.

In the Mathematics category, most topics identified as essential for a curriculum were needed at the "in-depth study (3)/high skill (3)" level. Calculus topics were considered essential at the "general coverage (2)" level for classwork in the Mechanical Engineering Technology and Manufacturing Engineering Technology curriculums.

For the Communications category, almost all topics were essential for classwork at the "in-depth study (3)" level. For laboratory, essential topics varied from all required in Industrial Engineering Technology to one required in Manufacturing Engineering Technology.

In the Social Sciences/Humanities category, the Mechanical Engineering Technology and the Mechanical Drafting and Design Technology identified only one topic each as essential, compared with the Manufacturing Engineering Technology and Industrial Engineering Technology curriculums which identified four and five topics as essential, respectively.

SUMMARY OF STUDY FINDINGS

This study determined the topics needed in Mechanical Engineering Technology, Mechanical Drafting and Design Technology, Manufacturing Engineering Technology, and Industrial Engineering Technology as perceived by employers, graduates, North Carolina instructors, and instructors in other states. It identified the levels of proficiency required in classwork and laboratory for each topic by curriculum as perceived by respondents. It determined that there were few differences in opinion held by subgroups of respondents concerning what should be in the curriculum. And, it identified those topics common to more than one of the programs being studied.

Topics requiring "in-depth" in classwork and/or "high skill" in laboratory in all curriculums were limited to three topical categories - Computer Usage, Mathematics, and Communications. These topics were computer basics, arithmetic, algebra, geometry, trigonometry, metric units & conversions, grammar/spelling/composition, oral communications, technical writing, and technical report writing. Other topics perceived to be required in all curriculums were blueprint reading, technical drafting fundamentals, computer aided drafting, machine metalworking processes, manufacturing processes, microcomputer usage, computer workstation usage, computer aided design, engineering applications for computers, jig & fixture design, physics-mechanics, physics-electrical, physics-fluids, physics-heat, analytical geometry, and conference communications.

For the Mechanical Engineering Technology curriculum, 15 of the 48 topics in the Technical Skills & Techniques category were identified as essential. Most of the topics (82%) in the categories other than Technical Skills & Techniques and Social Science/Humanities (one topic) were identified as essential.

For the Mechanical Drafting and Design Technology curriculum, 10 of the 48 topics in the Technical Skills & Techniques category were identified as essential. Thirty-four of the 51 topics (65%) in the categories other than Technical Skills & Techniques and Social Science/Humanities (one topic) were identified as essential.

For the Manufacturing Engineering Technology curriculum, 38 of the 48 topics (79%) in the Technical Skills & Techniques category were identified as essential. Forty-three of the 51 topics (84%) in the categories other than Technical Skills & Techniques and Social Science/Humanities (four topics) were identified as essential.

For the Industrial Engineering Technology curriculum, 28 of the 48 topics (58%) in the Technical Skills & Techniques category were identified as essential. Thirty of the 51 topics (59%) in the categories other than Technical Skills & Techniques and Social Science/Humanities (five topics) were identified as essential.

CHAPTER V

SUMMARY AND CONCLUSIONS

> "The purpose of collecting data
> is to provide a basis for action."
> -Dr. Kaoru Ishikawa

The purpose of this study was to identify the educational topics and the level of proficiency perceived to be required in these topics for selected two-year engineering technology programs offered in North Carolina Community College institutions. The investigation sought to answer the following questions: 1) What educational topics are perceived to be required for graduates of the four programs studied; 2) What are the levels of proficiency required in classwork and laboratory for these programs; 3) Are there any differences in the opinions of employers, graduates, North Carolina instructors, and national instructors concerning what should be in these programs; and 4) Which of the topics are common to more than one of the technologies being studied?

The study used a mailed questionnaire to gather responses to a 108 item topic inventory and six background information questions. The inventory was drafted using the survey of literature to provide an initial list of topics and then refined with the assistance of a state and national panel of experts.

The questionnaire was sent to 395 employers, graduates, and instructors of engineering technology programs. One-hundred-and-seventy-eight usable responses were received for a 45% response rate. Data collected from the questionnaire was subjected to statistical analysis using SAS computer programs. Analyses run on the data included frequencies and factor analysis. Comparisons were computed for topics required both by curriculum and among subgroups of respondents.

SUMMARY

The educational topics perceived as essential by respondents were identified for each of the four programs studied. Statistical analysis techniques used to identify these topics as essential were the frequency of response to proficiency levels and factor analysis. Proficiency levels required in classwork and laboratory were identified for each topic in each of the programs studied using frequencies of response. Differences in the opinions of employers, graduates, North Carolina instructors, and national instructors were determined for each topic in both classwork and laboratory. This was done by comparing the frequency of response of each subgroup to the response of the total group for each topic. Those cases where the majority response of a subgroup differed by more than one proficiency level from that of the total group were then identified. The topics common to more than one program were identified by listing the level of proficiency required for all topics identified as essential. These listings were compiled for all four programs into one table.

In addition, statistics were computed to help describe the general response to the study by program. The total number of essential topics identified for each curriculum were listed for classwork and laboratory. The total number of essential topics rated at each proficiency level were given for each curriculum by classwork and laboratory. And the total number of essential topics by topical category were itemized for each curriculum.

Included in the findings are tables for each of the four curriculums studied and a discussion of each curriculum. Also included are tables and discussion that address the common items between the four curriculums and how they relate.

CONCLUSIONS

Based on the review of literature and the analysis of data, the following conclusions were reached:

1. There was a high level of interest shown in the study by the respondents, based on the overall response of 45% return to a single mailed questionnaire with no follow up.

2. Each curriculum was perceived to be unique, judging from the overall responses to topics by curriculum.

3. There was general agreement among the four subgroups of respondents regarding the topics that should be in each curriculum.

4. There are discrepancies between the respondent opinions and existing North Carolina Department of Community Colleges curriculum guides.

5. There are discrepancies between respondent opinions and ABET criteria.

6. The Mechanical Drafting and Design Technology curriculum should be reviewed to determine if it is appropriately designated as an engineering technology curriculum.

7. The situation of varying levels of proficiency required in the Technical Skills & Techniques category topics would lend itself to special curriculum/course development activities.

8. The emphasis on Computer Usage topics in all four curriculums should be addressed.

9. The emphasis on laboratory for Mathematics and Communications topics should be addressed.

10. The results of this study should be used as a source of information to assist in revising curriculums to reflect current needs of industry served by North Carolina Community College institutions.

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APPENDICES

APPENDIX A

Summary of Basic Science and Mathematics Topics Most Needed by Engineering Technicians

	Architectural Technology	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
MECHANICS						
Statics	X	X	E	-	X	X
Fluid Mechanics	X	X	X	-	-	X
Properties of Materials	E	E	E	-	X	X
Strength of Materials	E	-	E	-	-	X
Dynamics	X	X	X	X	X	E
FUNDAMENTALS OF ELECTRICITY/ELECTRONICS						
Electric Fields	-	-	-	E	E	X
Magnetic Fields	-	-	-	E	E	X
D. C. Electricity	X	X	X	E	E	X
A. C. Electricity	X	X	X	E	E	X
Electronics	-	-	-	E	E	X
Electrical Devices	X	X	X	E	E	E
Electro-magnetics	-	-	-	X	E	X
LIGHT						
General Theory	X	X	X	X	X	X
Geometrical Optics	-	-	-	X	X	-
Physical Optics	-	X	-	X	X	-
Spectral Analysis	-	X	-	-	X	-

Summary of Basic Science and Mathematics Topics Most Needed by Engineering Technicians

	Architectural Technology	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
SOUND						
General Theory	X	X	-	X	X	-
Reception/ Transmission	X	-	-	X	X	-
HEAT						
General Theory	X	E	X	X	X	X
Heat Transfer	X	X	X	X	X	E
Thermo-dynamics	X	E	X	-	X	X
MODERN PHYSICS						
Structure of Atom	-	E	-	-	X	X
Relativity	-	X	-	-	X	-
Fission/Fusion Radioactivity	-	E	-	-	X	-
CHEMISTRY						
General Chemistry	-	E	X	-	X	X
Qualitative Chemistry	-	E	-	-	-	-
Quantitative Chemistry	-	E	-	-	-	-
Physical Chemistry	-	E	-	-	-	X
Organic Chemistry	-	E	-	-	-	-

Summary of Basic Science and Mathematics Topics Most Needed by Engineering Technicians

	Architectural Technology	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
BIOLOGY						
General Biology	-	X	-	-	-	-
Micro-biology	-	E	-	-	-	-
Ecology	X	X	-	-	-	-
Botany	-	-	-	-	-	-
Zoology	-	-	-	-	-	-
Genetics	-	-	-	-	-	-
GEOLOGY						
Physical Geology	X	-	X	-	-	-
Economic Geology	-	X	X	-	-	-
Structural Geology	-	-	X	-	-	-
Geophysics	-	-	X	-	-	-
Hydrology	X	-	E	-	-	-
DATA PROCESSING						
FORTRAN	-	X	X	X	X	X
BASIC	-	X	X	X	X	X
ALGEBRA						
Exponents/ Radicals	X	E	E	E	E	E
Scientific Notation	X	E	E	E	E	E
Algebraic Expressions	E	E	E	E	E	E
Equations/ Word Problems	E	E	E	E	E	E

Summary of Basic Science and Mathematics Topics Most Needed by Engineering Technicians

	Architectural Technology	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
ALGEBRA (con't)						
Determinants and Matrices	X	X	E	X	E	X
Solutions to Systems Equations	E	E	E	X	E	E
Factoring	X	E	E	X	E	E
Fractions	E	E	E	E	E	E
Quadratic Equations	X	E	E	X	E	E
Complex and Imaginary Numbers	X	X	X	X	E	X
Inequalities	X	X	X	X	E	X
Ratio and Proportion	E	E	E	E	E	E
Progressions	X	X	E	X	E	E
Series; Expansions	X	X	X	X	X	X
TRIGONOMETRY						
Angles	E	E	E	X	E	E
Trigonometric Functions	E	E	E	X	E	E
Right Triangles	E	E	E	X	E	E
Oblique Triangles	E	E	E	X	E	E
Graphs of Trig Functions	E	E	E	X	E	E
Inverse Trig Functions	X	X	E	X	X	E

Summary of Basic Science and Mathematics Topics Nost Needed by Engineering Technicians

	Architectural Engineering	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
LOGARITHMS						
Exponential and Log Functions	X	X	X	X	E	E
Logs of Trig Functions	X	X	X	X	E	E
GEOMETRY						
Plane Geometry	E	X	E	X	X	E
Solid Geometry	E	X	E	X	X	E
ANALYTIC GEOMETRY						
Rectangular Coordinates	E	X	E	X	E	E
Solving Equations Graphically	X	X	E	X	E	X
Graphs of Log Functions	X	X	X	X	X	X
Polar Coordinates	X	X	E	X	X	X
CALCULUS						
Differentiation	X	E	E	X	X	X
Integration	X	E	E	X	X	X
Differentiation of Functions	X	X	X	X	X	X
Differential Equations	X	X	X	X	X	X
Laplace Transforms	-	-	X	-	X	X

Summary of Basic Science and Mathematics Topics Most Needed by Engineering Technicians

	Architectural Engineering	Chemical Technology	Civil Engineering Technology	Computer Technology	Electronic Engineering Technology	Industrial Engineering Technology
STATISTICS						
Probability	-	X	X	-	X	E
Frequency Distributions	-	X	X	-	X	E
Variability	-	X	X	-	X	E
Sampling Theory	-	X	X	-	X	E
Hypothesis Testing	-	X	X	X	X	X

KNOWLEDGE AND SKILL INVENTORY

MECHANICAL/MANUFACTURING/INDUSTRIAL

GENERAL INSTRUCTIONS

Thank you for reading these general instructions prior to completing the inventory.

To qualify for this survey, you should be a member of one of the following groups - graduate of an engineering technician program, employer/supervisor of engineering technicians, or instructor in an engineering technician program; and have a background in, or experience with, mechanical, drafting and design, manufacturing, or industrial engineering technology. If you do not meet these criteria, please forward the inventory to an individual who meets the criteria or return it.

This survey is designed to identify the major topics which need to be provided by colleges to prepare those students in two-year engineering technician programs for subsequent industrial assignments. The topics listed are potential components for a two-year engineering technology curriculum. You are asked to evaluate the level of proficiency needed by graduates for each topic in two categories -- classwork and laboratory.

Your assistance in completing this inventory is important to the field. Your answers will be used to help identify the preparation required of future engineering technicians. Estimated time to complete: 20 minutes.

Thank you for your assistance in this study. All data will be grouped, thus specific information that you provide will remain confidential.

Please return the completed survey by May 15, 1987, in the enclosed envelope addressed to:

Mr. Luby Weaver, Associate Director
Engineering Technologies and Vocational Occupations
N. C. Department of Community Colleges
200 West Jones Street
Raleigh, NC 27603-1337

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL
ENGINEERING TECHNICIANS

Name: ______________________________
(Optional)

Position/Title: ______________________________
(Optional)

Employed By: ______________________________
(Optional)

1. Please circle the letter beside the word which best describes your employer's product or service by type.

   A. Agriculture
   B. Construction
   C. Education
   D. Government
   E. Manufacturing
   F. Public Utilities
   G. Research/Development
   H. Transportation
   I. Wholesale/Retail
   J. Other (specify)______________

2. Please circle the letter beside the group which you primarily represent as a respondent:

   a. Graduate of a two-year engineering technician program -
      Year graduated: 19_____ Major:______________
   b. Employer/supervisor of engineering technician(s)
      Number of years: ______________
   c. Instructor in engineering technician program
      Number of years:______________
   d. Other______________________________
      (Please specify group)

3. Please circle the letter beside the one engineering technician curriculum for which you are responding: (If you choose to respond to more than one category, please copy the form and complete a separate inventory for each curriculum. Your answers on the inventory should indicate what you think should be included in one specific curriculum.)

   a. Mechanical Engineering Technology
   b. Mechanical Drafting and Design Technology
   c. Manufacturing (Engineering) Technology
   d. Industrial Engineering Technology
   e. Other______________________________
      (Please specify curriculum)

N. C. Department of Community Colleges

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL ENGINEERING TECHNICIANS

ITEM #	TOPIC	PROFICIENCY LEVELS REQUIRED CLASSWORK NONE HIGH	 LABORATORY NONE HIGH
Example:	HISTORY OF TECHNOLOGY	0 1 [✓ 2] 3	[✓ 0] 1 2 3
I.	**TECHNICAL SKILLS AND TECHNIQUES**		
A.	BLUEPRINT READING	0 1 2 3	0 1 2 3
B.	TECHNICAL DRAFTING FUNDAMENTALS	0 1 2 3	0 1 2 3
C.	DRAFTING - MECHANICAL COMPONENTS	0 1 2 3	0 1 2 3
D.	DRAFTING - SMALL MECHANICAL SYSTEMS	0 1 2 3	0 1 2 3
E.	DESCRIPTIVE GEOMETRY	0 1 2 3	0 1 2 3
F.	COMPUTER AIDED DRAFTING	0 1 2 3	0 1 2 3
G.	MACHINE METALWORKING PROCESSES	0 1 2 3	0 1 2 3
H.	PLASTIC MACHINING PROCESSES	0 1 2 3	0 1 2 3
I.	NC/CNC MACHINE PROCESSES	0 1 2 3	0 1 2 3
J.	MANUFACTURING PROCESSES	0 1 2 3	0 1 2 3
K.	NONDESTRUCTIVE EXAMINATION (NDE) TECHNIQUES	0 1 2 3	0 1 2 3
L.	DESTRUCTIVE EXAMINATION TECHNIQUES	0 1 2 3	0 1 2 3
M.	METROLOGY	0 1 2 3	0 1 2 3
N.	MATERIAL HANDLING, PROCESSING AND ASSEMBLING METHODS	0 1 2 3	0 1 2 3
O.	COMPUTER AIDED MANUFACTURING	0 1 2 3	0 1 2 3
P.	AUTOMATED SYSTEMS	0 1 2 3	0 1 2 3
Q.	ROBOTICS	0 1 2 3	0 1 2 3
R.	CONTROL SYSTEM FUNDAMENTALS	0 1 2 3	0 1 2 3
S.	CONTROL SYSTEM DESIGN	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL ENGINEERING TECHNICIANS

ITEM #	TOPIC	PROFICIENCY LEVELS REQUIRED CLASSWORK NONE HIGH	 LABORATORY NONE HIGH
T.	ELECTRONIC INSTRUMENTATION	0 1 2 3	0 1 2 3
U.	PNEUMATIC INSTRUMENTATION	0 1 2 3	0 1 2 3
V.	HYDRAULIC INSTRUMENTATION	0 1 2 3	0 1 2 3
W.	HEATING SYSTEM DESIGN	0 1 2 3	0 1 2 3
X.	AIR CONDITIONING SYSTEM DESIGN	0 1 2 3	0 1 2 3
Y.	REFRIGERATION SYSTEM DESIGN	0 1 2 3	0 1 2 3
Z.	ELECTRICAL DEVICES	0 1 2 3	0 1 2 3
AA.	ELECTROMECHANICAL DEVICES	0 1 2 3	0 1 2 3
AB.	INDUSTRIAL ELECTRICITY	0 1 2 3	0 1 2 3
AC.	CIRCUIT ANALYSIS	0 1 2 3	0 1 2 3
AD.	ELECTRONIC DEVICES AND SYSTEMS	0 1 2 3	0 1 2 3
AE.	INDUSTRIAL ELECTRONICS	0 1 2 3	0 1 2 3
AF.	MECHANICAL DEVICES AND SYSTEMS	0 1 2 3	0 1 2 3
AG.	MACHINE CARE/MAINTENANCE	0 1 2 3	0 1 2 3
AH.	LUBRICATION	0 1 2 3	0 1 2 3
AI.	INDUSTRIAL SAFETY	0 1 2 3	0 1 2 3
AJ.	INDUSTRIAL ORGANIZATION AND MANAGEMENT	0 1 2 3	0 1 2 3
AK.	QUALITY CONTROL	0 1 2 3	0 1 2 3
AL.	QUALITY ASSURANCE PRACTICES	0 1 2 3	0 1 2 3
AM.	STATISTICAL PROCESS CONTROL	0 1 2 3	0 1 2 3
AN.	METHODS IMPROVEMENT	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL ENGINEERING TECHNICIANS

		PROFICIENCY LEVELS REQUIRED	
		CLASSWORK NONE HIGH	LABORATORY NONE HIGH
ITEM #	TOPIC		
AO.	JOB ANALYSIS AND EVALUATION	0 1 2 3	0 1 2 3
AP.	INDUSTRIAL SUPERVISION	0 1 2 3	0 1 2 3
AQ.	FINANCE, ACCOUNTING AND ECONOMIC ANALYSIS	0 1 2 3	0 1 2 3
AR.	MANUFACTURING CYCLES	0 1 2 3	0 1 2 3
AS.	PRODUCTION METHODS	0 1 2 3	0 1 2 3
AT.	PRODUCTION PLANNING	0 1 2 3	0 1 2 3
AU.	CODES AND STANDARDS	0 1 2 3	0 1 2 3
AV.	INVENTORY MANAGEMENT	0 1 2 3	0 1 2 3
AW.	______________________	0 1 2 3	0 1 2 3
AX.	______________________	0 1 2 3	0 1 2 3
II.	TECHNICAL SCIENCES		
A.	STATICS	0 1 2 3	0 1 2 3
B.	DYNAMICS	0 1 2 3	0 1 2 3
C.	STRENGTH OF MATERIALS	0 1 2 3	0 1 2 3
D.	ENGINEERING MATERIALS TESTING	0 1 2 3	0 1 2 3
E.	PHYSICAL METALLURGY	0 1 2 3	0 1 2 3
F.	ENGINEERING MATERIALS - METALLIC	0 1 2 3	0 1 2 3
G.	ENGINEERING MATERIALS - NON-METALLIC	0 1 2 3	0 1 2 3
H.	FLUID MECHANICS	0 1 2 3	0 1 2 3
I.	FLUID POWER	0 1 2 3	0 1 2 3
J.	ELECTRICAL FUNDAMENTALS	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL
ENGINEERING TECHNICIANS

ITEM # TOPIC		PROFICIENCY LEVELS REQUIRED	
		CLASSWORK NONE HIGH	LABORATORY NONE HIGH
K.	CIRCUIT ANALYSIS	0 1 2 3	0 1 2 3
L.	ELECTRONIC PRINCIPLES	0 1 2 3	0 1 2 3
M.	APPLIED THERMODYNAMICS AND HEAT TRANSFER	0 1 2 3	0 1 2 3
N.	______________________________	0 1 2 3	0 1 2 3
O.	______________________________	0 1 2 3	0 1 2 3
III.	**COMPUTER USAGE**		
A.	COMPUTER BASICS	0 1 2 3	0 1 2 3
B.	MICROCOMPUTER USAGE	0 1 2 3	0 1 2 3
C.	PROGRAMMING LANGUAGES	0 1 2 3	0 1 2 3
D.	COMPUTER WORKSTATION USAGE	0 1 2 3	0 1 2 3
E.	COMPUTER AIDED DESIGN	0 1 2 3	0 1 2 3
F.	ENGINEERING APPLICATIONS FOR COMPUTERS	0 1 2 3	0 1 2 3
G.	SOFTWARE APPLICATIONS PROGRAM USAGE	0 1 2 3	0 1 2 3
H.	______________________________	0 1 2 3	0 1 2 3
I.	______________________________	0 1 2 3	0 1 2 3
IV.	**TECHNICAL DESIGN**		
A.	MECHANISMS	0 1 2 3	0 1 2 3
B.	MACHINE DESIGN	0 1 2 3	0 1 2 3
C.	JIG AND FIXTURE DESIGN	0 1 2 3	0 1 2 3
D.	TOOL AND DIE DESIGN	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL
ENGINEERING TECHNICIANS

ITEM #	TOPIC	PROFICIENCY LEVELS REQUIRED	
		CLASSWORK NONE HIGH	LABORATORY NONE HIGH
E.	COMPUTER AIDED DESIGN	0 1 2 3	0 1 2 3
F.	PLANT LAYOUT	0 1 2 3	0 1 2 3
G.	____________________	0 1 2 3	0 1 2 3
H.	____________________	0 1 2 3	0 1 2 3
V.	**BASIC SCIENCES**		
A.	PHYSICS - MECHANICS	0 1 2 3	0 1 2 3
B.	PHYSICS - ELECTRICAL	0 1 2 3	0 1 2 3
C.	PHYSICS - FLUIDS	0 1 2 3	0 1 2 3
D.	PHYSICS - HEAT	0 1 2 3	0 1 2 3
E.	PHYSICS - LIGHT	0 1 2 3	0 1 2 3
F.	PHYSICS - SOUND	0 1 2 3	0 1 2 3
G.	PHYSICS - ATOMIC	0 1 2 3	0 1 2 3
H.	CHEMISTRY	0 1 2 3	0 1 2 3
I.	LIFE SCIENCE	0 1 2 3	0 1 2 3
J.	__________________________	0 1 2 3	0 1 2 3
K.	__________________________	0 1 2 3	0 1 2 3
VI.	**MATHEMATICS**		
A.	ARITHMETIC	0 1 2 3	0 1 2 3
B.	ALGEBRA	0 1 2 3	0 1 2 3
C.	GEOMETRY	0 1 2 3	0 1 2 3
D.	TRIGONOMETRY	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL ENGINEERING TECHNICIANS

	PROFICIENCY LEVELS REQUIRED	
	CLASSWORK	LABORATORY
ITEM # TOPIC	NONE HIGH	NONE HIGH
E. ANALYTICAL GEOMETRY	0 1 2 3	0 1 2 3
F. DIFFERENTIAL CALCULUS	0 1 2 3	0 1 2 3
G. INTEGRAL CALCULUS	0 1 2 3	0 1 2 3
H. DIFFERENTIAL EQUATIONS	0 1 2 3	0 1 2 3
I. BASIC DIGITAL MATHEMATICS	0 1 2 3	0 1 2 3
J. STATISTICS	0 1 2 3	0 1 2 3
K. METRIC UNITS AND CONVERSIONS	0 1 2 3	0 1 2 3
L. ____________________	0 1 2 3	0 1 2 3
M. ____________________	0 1 2 3	0 1 2 3
VII. COMMUNICATIONS		
A. GRAMMAR, SPELLING AND COMPOSITION	0 1 2 3	0 1 2 3
B. ORAL COMMUNICATIONS	0 1 2 3	0 1 2 3
C. TECHNICAL WRITING	0 1 2 3	0 1 2 3
D. TECHNICAL REPORT WRITING	0 1 2 3	0 1 2 3
E. CONFERENCE COMMUNICATIONS	0 1 2 3	0 1 2 3
F. ____________________	0 1 2 3	0 1 2 3
G. ____________________	0 1 2 3	0 1 2 3
VIII. SOCIAL SCIENCE/HUMANITIES		
A. INTRODUCTION TO TECHNOLOGY	0 1 2 3	0 1 2 3
B. ECONOMICS IN TECHNOLOGY	0 1 2 3	0 1 2 3

KNOWLEDGE AND SKILL INVENTORY
MECHANICAL/MANUFACTURING/INDUSTRIAL ENGINEERING TECHNICIANS

		PROFICIENCY LEVELS REQUIRED	
		CLASSWORK NONE HIGH	LABORATORY NONE HIGH
ITEM #	TOPIC		
C.	APPLIED PSYCHOLOGY	0 1 2 3	0 1 2 3
D.	SOCIAL SCIENCE	0 1 2 3	0 1 2 3
E.	INDUSTRIAL RELATIONS	0 1 2 3	0 1 2 3
F.	PHILOSOPHY	0 1 2 3	0 1 2 3
G.	LITERATURE	0 1 2 3	0 1 2 3
H.	MUSIC	0 1 2 3	0 1 2 3
I.	ART	0 1 2 3	0 1 2 3
J.		0 1 2 3	0 1 2 3
K.		0 1 2 3	0 1 2 3

PLEASE COMMENT ON ANY THOUGHTS RELATED TO THIS SURVEY THAT HAVE OCCURRED TO YOU IN THE PROCESS OF COMPLETING THE INVENTORY:

THANK YOU FOR RETURNING THIS IMPORTANT SURVEY BY MAY 15, 1987.
PLEASE RETURN IT IN THE ENCLOSED PREPAID ENVELOPE TO:

Mr. Luby S. Weaver, Associate Director
Engineering Technologies and Vocational Occupations
N. C. Department of Community Colleges
200 West Jones Street
Raleigh, NC 27603-1337

APPENDIX C

CRITERIA FOR
ACCREDITING PROGRAMS
IN ENGINEERING TECHNOLOGY:
CURRICULUM ELEMENTS*

Effective for Evaluations

During the 1986-87 Academic Year

Accreditation Board for Engineering and Technology, Inc.
345 East 47th Street
New York, New York 10017-2397

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*Taken directly from ABET "Criteria for Accrediting Programs in Engineering Technology"

C. Curriculum Elements

The quantitative criteria listed in A.1. and 2. above are now discussed as providing a minimum foundation for the preparation of an engineering technician or engineering technologist.

1. Technical Sciences - Subject matter in an engineering technology program has its roots in mathematics and basic science and carries knowledge further toward application. Courses are designated to supply the core of technological knowledge students need in their chosen profession. The same subject areas are included, with more emphasis on application than the "engineering science" of an engineering program.

2. Technical Specialties

a. Technical Skills and Techniques - These are courses in which the student would acquire the necessary skills and knowledge of appropriate methods, procedures, and techniques - such as graphics, problem solving, processes, construction techniques, instrumentation techniques, production methods, field operations, plant operations, safety, and maintenance. Technology laboratory manuals, experiments, projects, and activities should clearly reflect the orientation of the program towards the education of the student in the modern techniques of applied design, construction, operation, maintenance, testing, and some production processes.

b. Technical Design Courses - These are courses in practice-oriented standard design applied to work in the field - such as construction - in which students acquire experience in carrying out established design procedures in their own areas of specialization. The key to this type of technical design lies in the fact that the courses would follow established design concepts developed by engineering and that there would be prime emphasis on standard design procedures and practices. Many of these design methods have already been included in handbooks or standard computer methods for various branches of engineering. These courses would require an understanding of the application of mathematics and science, for example to such activities as air conditioning systems design, duct design, piping design, amplifier design, computer component and circuit design, plant layout, materials handling operations, and/or civil engineering technology applications such as road design.

3. Technical Electives - Technical electives include any related technical courses which support the student's career interest (e.g., electronic circuits for a student in mechanical engineering technology).

4. Basic Sciences and Mathematics

a. Allocations within this group between basic sciences and mathematics will depend partly upon the specific program needs. For example, electronics might require a higher fraction of the total in mathematics than environmental engineering technology, which may have a greater basic sciences requirement. Courses in computer programming may not be included in the category of basic sciences and mathematics in satisfying the minimum quantitative requirements.

b. Basic Sciences - In a study of science, the objective is to acquire fundamental knowledge about nature and its phenomena. Toward this end, the courses should emphasize the understanding, measurement, and quantitative expression of the phenomena of nature. Laboratory work, including experimentation, observation, and accurate measurement, is a required part of the study of physical science. The basic sciences component of an engineering technology program may include physics, chemistry, and the life and earth sciences in accordance with specific program needs.

c. Mathematics - College algebra is the normal beginning point for the study of mathematics in engineering technology programs, and is the basis for the specified minimum mathematics credit and competency requirements. (See sections A.1.c. and A.2.c. above.) Program requirements should include carefully selected topics, suited to the individual program, from algebra through trigonometric functions to high levels of mathematics. In baccalaureate programs, particularly, the study of the concepts and applications of calculus should be included in the program to ensure that students are professionally literate and to permit use of this mathematical tool in technological courses. Study of the concepts of calculus shall also be included in associate degree programs unless alternative subjects in mathematics beyond algebra and trigonometric functions are specified in the applicable specific program criteria as developed by the professional societies and approved by ABET. (See section IV above.)

5. Communications, Humanities, and Social Sciences

a. Communications - Good oral and written communications are considered by ABET to be a necessary achievement of a college graduate. Technically trained individuals should not be considered educated regardless of the depth of their technical capability if they cannot communicate, both orally and in writing, their technical findings, thoughts, and philosophy to others around them. Since it is by practice that the real importance of a specific aspect of educational endeavor is demonstrated to the student, a good technical educator will insist that reports be neat, grammatically correct, and lucid. Thus the visiting team will be looking for evidence that both oral and written communications have been taken into account in the review and evaluation of student work.

b. Social Science/Humanities - It is important that the student acquire an appreciation and understanding of our rich cultural heritage, the complexities of interpersonal relationships, an understanding of the interrelationship between technology and society, and a system of values essential for intelligent and discerning judgments. There will be variation in the specific courses offered in this general area from institution to institution. This by no means minimizes the importance of these courses to broaden the student in the general education area. Skill courses such as physical education or military drill do not qualify as social-humanistic studies.

6. Computer Literacy - The computer is one of the most important and

versatile tools in the practice of engineering and engineering technology. Engineering technicians/technologists are dependent on it to effectively discharge their job functions. It is therefore essential that students acquire a working knowledge of computer usage in the engineering technology field. Instruction must be included in one or more of the computer languages commonly used in the practice of engineering technology. Assignments should concentrate on using the computer in technical problem solving applications as contrasted to traditional data processing problems. Following formal instruction or demonstrated proficiency in programming, students should gain experience using the computer in appropriate technical courses.

APPENDIX D

STATE AND NATIONAL REVIEW PANEL

ASSESSMENT OF KNOWLEDGE AND SKILLS NEEDED IN SELECTED ENGINEERING TECHNICIAN'S FIELDS

North Carolina Panel Members

John Burns
Head, Engineering Technology Department
Rowan Technical College
Salisbury, NC

Richard Croom
Director, Division of Engineering Technology
Asheville-Buncombe Technical College
Asheville, NC

H. Gene Hornick
Dean, Engineering Technology
Wake Technical College
Raleigh, NC

George Timblin
Division Head, Technology
Central Piedmont Community College
Charlotte, NC

Gerald K. Thompson
Chairman, Engineering Technology Division
Catawba Valley Technical College
Hickory, NC

National Panel Members

Stanley M. Brodsky
New York City Technical College
300 Jay Street, Room J633
Brooklyn, NY 11201
Phone 718-643-3576

Durward Huffman, Director, Engineering Technology
Nashville State Technical Institute
120 White Bridge Road
Nashville, TN 37209
Phone 615-386-1474

Mark Stratton, Manager, Manufacturing Engineering Education
Society of Manufacturing Engineers
One SME Drive, P. O. Box 930
Dearborn, MI 48128
Phone 313-271-1500

Maynard J. Iverson, Head, Agriculture Education Department
School of Education
University of Georgia
Athens, GA 30602
Phone 404-542-1204

Elliot R. Eisenberg
Penn State University - Hazelton
Hazelton, PA 18201
Phone 717-454-8731

David Wells
Ohio College of Applied Science
University of Cincinnati
Cincinnati, OH 45210
Phone 513-475-4243

Kenneth Merkel
Industrial Systems Technology
University of Nebraska - Omaha
Omaha, NE 68182
Phone 402-554-2536

Walter E. Thomas
Engineering Technology
ULAR
2801 S. University St.
Little Rock, AR 72204

Timothy I. Edwards
Carolina Power and Light Company
Box 1551
Raleigh, NC 27602

APPENDIX E

LETTER REQUESTING PARTICIPATION
IN STUDY OF NORTH CAROLINA
INSTITUTIONS

DEPARTMENT OF COMMUNITY COLLEGES
NORTH CAROLINA STATE BOARD OF COMMUNITY COLLEGES
RALEIGH 27603-1712

ROBERT W. SCOTT
STATE PRESIDENT

919-733-7051

April 9, 1987

MEMO TO: Deans or Division Heads With Administrative Responsibilities for the Following Engineering Technology Curriculums:

Industrial Engineering Technology (T-047)
Manufacturing Engineering Technology (T-050)
Mechanical Drafting and Design Technology (T-043)
Mechanical Engineering Technology (T-051)

FROM: Luby S. Weaver, Associate Director
Engineering Technologies and Vocational Occupations

SUBJECT: Assessment of Knowledge and Skills Needed in Selected Engineering Technician Fields

The Program Development Services Section is undertaking a major curriculum project designed to assess the knowledge and skills needed in selected engineering technology fields. The objective of this project is to identify the major topics and the level to which they need to be taught to prepare students for employment as engineering technicians. If this project is to accomplish its objective, we will need the help of you and your staff.

A knowledge and skill inventory instrument has been developed and reviewed by an advisory committee made up of administrators and instructors of engineering technology programs in North Carolina and representatives from engineering technology programs in other states. It is now being printed for distribution.

We need your help to identify the persons who should complete the inventory instrument. It is estimated that it will take approximately 20-30 minutes to respond to the inventory statements.

CC-S-87-22

EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER

The target group for this study will include:

1. Instructors of the following curriculum programs in North Carolina community and technical colleges:

    Industrial Engineering Technology (T-047)
    Manufacturing Engineering Technology (T-050)
    Mechanical Drafting and Design Technology (T-043)
    Mechanical Engineering Technology (T-051)

2. Representatives of the selected engineering technology programs in other states.

3. Employers of technicians trained in the selected technologies.

4. Recent graduates (within 5 years) of the selected curriculums.

Data collected will be statistically analyzed and a formal reporting of the finding will be distributed throughout the North Carolina Community College System.

We expect to send the inventory instrument out of this office on April 24, 1987, with the request that it be filled out and returned by May 15, 1987.

It is requested that you return the enclosed form(s) with the information needed as soon as practical, but no later than April 24, 1987. Please send a separate form for each of the selected curriculums for which you have approval to offer. If you should have questions, please contact me by telephone at 919-733-7051, extension 439.

Your cooperation and assistance is appreciated.

rs

Enclosure

INSTITUTION:____

CONTACT PERSON:____

A. Please check the curriculum for which the persons listed are being recommended for completing the knowledge and skills inventory.
   _____ Industrial Engineering Technology (T-047)
   _____ Manufacturing Engineering Technology (T-050)
   _____ Mechanical Drafting and Design Technology (T-043)
   _____ Mechanical Engineering Technology (T-051)

B. Please list instructors in your institution that should complete the inventory instrument for this curriculum.

C. Please list the names and complete mailing addresses of 3 to 5 employers of technicians with the skills taught in this curriculum.

	NAME	ADDRESS
1.		
2.		
3.		
4.		
5.		

D. Please list the names and complete mailing addresses of 3 to 5 recent graduates (within 5 years) of this curriculum that are employed as technicians in the field for which they were trained.

	NAME	ADDRESS
1.		
2.		
3.		
4.		
5.		

Thank you for your assistance in this very important project. This information is needed before **April 24, 1987.**

Return to: Luby S. Weaver, Associate Director
Engineering Technologies and Vocational Occupations
N. C. Department of Community Colleges
200 West Jones Street, Room 439 Caswell Building
Raleigh, NC 27603-1337

APPENDIX F

NORTH CAROLINA COMMUNITY COLLEGE INSTITUTIONS SURVEYED THAT OFFER THE ENGINEERING TECHNOLOGY PROGRAMS INCLUDED IN THE STUDY

Mechanical Engineering Technology (T-051)

Asheville-Buncombe Technical College
Blue Ridge Technical College
Catawba Valley Technical College
Central Piedmont Community College
Davidson County Community College
Gaston College
Isothermal Community College
Wake Technical College

Mechanical Drafting and Design Technology (T-043)

Anson Technical College
Asheville-Buncombe Technical College
Beaufort County Community College
Blue Ridge Technical College
Caldwell Community College and Technical Institute
Cape Fear Technical Institute
Central Carolina Technical College
College of the Albemarle
Craven Community College
Forsyth Technical College
Guilford Technical Community College
Isothermal Community College
Lenoir Community College
Richmond Community College
Rowan Technical College
Stanly Community College
Surry Community College
Technical College of Alamance
Wayne Community College
Western Piedmont Community College
Wilson County Technical College

Manufacturing Engineering Technology (T-050)

Central Piedmont Community College
Forsyth Technical College
Pitt Community College
Rowan Technical College
Stanly Community College
Western Piedmont Community College
Wilson County Technical College

Industrial Engineering Technology (T-047)

Blue Ridge Technical College
Catawba Valley Technical College
Gaston College
Lenoir Community College
Wake Technical College
Wayne Community College
Western Piedmont Community College

APPENDIX G

INSTITUTIONS SURVEYED IN STATES OTHER THAN NORTH CAROLINA WITH ABET-ACCREDITED TWO-YEAR ENGINEERING TECHNOLOGY PROGRAMS

Mechanical Engineering Technology (T-051)

Bluefield State College
Broome Community College
Chattanooga State Technical Community College
University of Cincinnati, Ohio College of Applied Science
University of DC, Van Ness Campus
Franklin Institute of Boston
Franklin University
Hartford State Technical College
Hudson Valley Community College
Kansas Technical Institute
Lake Superior State College
Lawrence Institute of Technology
Lowell, University of
Memphis State Technical Institute
Mercer Co. Community College
Midlands Technical College
Milwaukee School of Engineering
Mohawk Valley Community College
Nashville State Technical Institute
New Hampshire Technical Institute
New Mexico State University
New York City Technical College
SUNY, A & T, Canton
SUNY, A & T, Morrisville
Oregon Institute of Technology
PSU, Berks
PSU, Hazleton
PSU, Worthington-Scranton
Purdue University, W. Lafayette
Purdue University, Calumet
St. Louis CC at Florissant Valley
San Francisco, City College of
Southern Colorado, University of
Southern Technical Institute
Spartanburg Technical College
Spring Garden College
Stark Technical College
Temple University, College of E.T.
Thames Valley State Technical College
Toledo, University of, Community and Technical College
Trident Technical College
Vermont Technical College
Waterbury State Technical College
Youngstown State University
UNC-Charlotte
Georgia Southern College

Old Dominion University
Wentworth Institute of Technology
Western Kentucky University

Mechanical Drafting and Design Technology (T-043)

Chattanooga State Technical Community College
East Tennessee State University
Lake Superior State College
Michigan Technical University
Monroe Community College
University of Nebraska at Omaha
SUNY, A & T , Alfred
Ricks College
Rochester Institute of Technology
San Francisco, City College of
Stark Technical College
Toledo, University of, Community and Technical College
Nebraska at Omaha, University of
Waterbury State Technical College
Wentworth Institute of Technology

Manufacturing Engineering Technology (T-050)

East Tennessee State University
Hartford State TC
Nebraska at Omaha, University of
Purdue University at Indianapolis
Purdue University, W. Lafayette
SUNY, A & T, Farmington
Ricks College
Thames Valley State Technical College
University of Nebraska at Omaha
Wentworth Institute of Technology

Industrial Engineering Technology (T-047)

Memphis State Technical Institute
Nashville State Technical Institute
Purdue University, Calument
Purdue University, W. Lafayette
Purdue University at Indianapolis
Southern Technical Institute
Toledo, University of Community and Technical College
Walters State Community College
Wentworth Institute of Technology

APPENDIX H

LETTER INTRODUCING THE INVENTORY TO NORTH CAROLINA RESPONDENTS

DEPARTMENT OF COMMUNITY COLLEGES
NORTH CAROLINA STATE BOARD OF COMMUNITY COLLEGES
RALEIGH 27603-1712

ROBERT W. SCOTT
STATE PRESIDENT

919-733-7051

April 24, 1987

MEMO TO: Instructors of the Following Engineering Technology Curriculums:

Industrial Engineering Technology (T-047)
Manufacturing Engineering Technology (T-050)
Mechanical Drafting and Design Technology (T-043)
Mechanical Engineering Technology (T-051)

FROM: Luby S. Weaver, Associate Director
Engineering Technologies and Vocational Occupations

SUBJECT: Assessment of Knowledge and Skills Needed in Selected Engineering Technician Fields

Enclosed is a copy of the survey instrument designed to assess current knowledge and skills that are needed in mechanical, manufacturing and industrial engineering technology curriculum programs. This information will be used to identify common core competencies with those curricula such as Computer Aided Drafting (CAD) and to provide base data for competency based curriculum development projects.

We expect to include employers, former graduates and instructors in this study. We need your help with this important project. Please complete the survey instrument and return it by May 15, 1987.

Data collected will be statistically analyzed and a formal reporting of the finding will be distributed throughout the North Carolina Community College System.

If you should have questions, please contact me by telephone at 919-733-7051, extension 439.

rs

Enclosure

EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER

DEPARTMENT OF COMMUNITY COLLEGES
NORTH CAROLINA STATE BOARD OF COMMUNITY COLLEGES
ROBERT W. SCOTT
STATE PRESIDENT
RALEIGH 27603-1712
919-733-7051

April 24, 1987

MEMO TO: Employer of Engineering Technicians

FROM: Luby S. Weaver, Associate Director
Engineering Technologies and Vocational Occupations

SUBJECT: Assessment of Knowledge and Skills Needed in Selected Engineering Technician Fields

The North Carolina Department of Community Colleges, Program Development Services Section, is undertaking a major curriculum project designed to assess the knowledge and skills needed in selected engineering technology fields. The objective of this project is to identify the major topics and the level to which they need to be taught to prepare students for employment as engineering technicians. Your firm has been identified as an employer of two year associate degree engineering technology graduates. We need your help with this very important study.

The enclosed survey instrument is designed to assess the knowledge and skills needed in the following two year associate degree curriculum programs.

Industrial Engineering Technology (T-047)
Manufacturing Engineering Technology (T-050)
Mechanical Drafting and Design Technology (T-043)
Mechanical Engineering Technology (T-051)

This survey is being completed by selected employers, recent graduates and community college engineering technology instructors. As an employer of our graduates, your response is very important to this study. Please encourage the appropriate persons in your firm to complete and return this survey by May 15, 1987. Use a separate form for each technology if you employ technicians in more than one of the programs that are listed. Two survey forms are enclosed and additional copies can be supplied if needed. A self-addressed envelope is also enclosed for your convenience.

If you should have questions, please contact Luby Weaver or Rhonda Stephenson at 919-733-7051, Extension 439. Thank you for your cooperation and assistance.

rs

Enclosures

EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER

DEPARTMENT OF COMMUNITY COLLEGES
NORTH CAROLINA STATE BOARD OF COMMUNITY COLLEGES
RALEIGH 27603-1712

ROBERT W. SCOTT
STATE PRESIDENT

919-733-7051

April 24, 1987

MEMO TO: Graduates of Engineering Technology Curriculums

FROM: Luby S. Weaver, Associate Director LSW
Engineering Technologies and Vocational Occupations

SUBJECT: Assessment of Knowledge and Skills Needed in Selected Engineering Technician Fields

The North Carolina Department of Community Colleges, Program Development Services Section, is undertaking a major curriculum project designed to assess the knowledge and skills needed in selected engineering technology fields. The objective of this project is to identify the major topics and the level to which they need to be taught to prepare students for employment as engineering technicians. You have been identified as a recent graduate. We need your help with this very important study.

The enclosed survey instrument is designed to assess the knowledge and skills needed in the following two year associate degree curriculum programs.

Industrial Engineering Technology (T-047)
Manufacturing Engineering Technology (T-050)
Mechanical Drafting and Design Technology (T-043)
Mechanical Engineering Technology (T-051)

This survey is being completed by selected graduates, employers of engineering technicians and community college engineering technology instructors. As one of our recent graduates, your response is very important to this study. Please complete the survey and return it by May 15, 1987. A self-addressed envelope is also enclosed for your convenience.

If you should have questions, please contact Luby Weaver or Rhonda Stephenson at 919-733-7051, Extension 439. Thank you for your cooperation and assistance.

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Enclosures

EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER

APPENDIX I

LETTER INTRODUCING THE INVENTORY TO RESPONDENTS IN STATES OTHER THAN NORTH CAROLINA

MEMORANDUM

TO: Dean/Director/Chairman of Engineering Technology

FROM: Frank Gourley

SUBJECT: Knowledge and Skill Inventory: Mechanical/Manufacturing/Industrial Engineering Technicians

DATE: April 24, 1987

The help of your staff is requested in compiling a knowledge and skill inventory for mechanical, manufacturing, and industrial engineering technicians. The study will analyze responses of instructors in selected ABET accredited associate degree programs, as well as employers, graduates, and instructors from North Carolina community college institutions.

As an administrator in direct charge of ABET accredited associate degree engineering technology programs, please request the assistance of your staff in completing the attached inventory. Separate inventories should be completed if your institution offers more than one of the curriculums identified by the inventory.

Please have the inventory completed and returned as soon as possible - by May 15, 1987 at the latest. It should take about 20 minutes to complete. The preliminary results of the survey will be made available at the 1987 Annual Conference of the American Society for Engineering Education (ASEE) at Reno, Nevada in mid-June.

This survey is being conducted for the North Carolina Department of Community Colleges. The results will be used in curriculum review and revision activities with the two-year community college institutions in North Carolina that offer engineering technology programs. A summary of the results will be available on request.

If you have any questions about the study, write me at the address below, or call evenings at 919/828-5116. Please return the inventory to the address on the enclosed envelope.

Thanks also for the prompt assistance of you and your staff. Hope to see you in Reno!

Frank

Dr. Frank A. Gourley, Jr.
3305 Trenton Road
Raleigh, NC 27607

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Enclosures

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APPENDIX J

INSTITUTIONS REPRESENTED BY THE RESPONDENTS

OTHER STATES

	MET	MDT	MFG	IET
Bluefield State College	X			
Broome Community College	X			
East Tennessee State University		X	X	
Kansas Technical Institute	X			
Lake Superior State College	X	X		
Lawrence Institute of Technology	X			
Michigan Technological University	X			
Midlands Technical College	X			
Milwaukee School of Engineering	X			
Mohawk Valley Community College	X			
Monroe Community College		X		
New Hampshire Technical Institute	X			
Oregon Institute of Technology	X			
Penn State University - Hazleton	X			
Purdue University - Calumet	X			X
Purdue University, W. Lafayette	X		X	X
Purdue University at Indianapolis			X	
Spartanburg Technical College	X			
SUNY, A & T, Alfred		X		
Thames Valley State Technical College	X			
University of Lowell	X			
University of Nebraska		X	X	
University of Toledo		X		
Vermont Technical College	X			
Walters State Community College				X
Waterbury State Technical College	X			
Wentworth Institute of Technology	X		X	
Unknown Institution	XXXX	X	XX	X
Total	24	7	7	4

INSTITUTIONS REPRESENTED BY THE RESPONDENTS

NORTH CAROLINA

	MET	MDT	MFG	IET
Beaufort County Community College		X		
Catawba Valley Community College	X			X
Central Carolina Technical College		X		
Central Piedmont Community College	XXXXX		XXXX	
College of the Albemarle		X		
Craven Community College		X		
Davidson County Community College	X		X	
Forsyth Technical College		XX		
Guilford Technical Community College		XX		
Lenoir Community College		X		X
Rowan Technical College	X	XXX	XX	X
Stanly Community College			X	
Technical College of Alamance		XX		
Wake Technical College	XX			X
Wayne Community College		X		X
Western Piedmont Community College				X
Wilson County Technical College			X	
Total	10	15	9	6

APPENDIX K

RESPONSE TO THE SURVEY QUESTIONNAIRE, BY SUBGROUP

	Total Number Receiving Survey	Number Returning Survey
Mechanical Engineering Technology (T-051)		
Instructors	13	10
Employers	22	11
Graduates	26	12
Out-of-State Instructors	49	24
Total	110	57
Mechanical Drafting and Design Technology (T-043)		
Instructors	23	14
Employers	68	23
Graduates	76	25
Out-of-State Instructors	15	7
Total	182	69
Manufacturing Engineering Technology (T-050)		
Instructors	10	9
Employers	19	9
Graduates	13	3
Out-of-State Instructors	7	7
Total	49	28
Industrial Engineering Technology (T-047)		
Instructors	6	6
Employers	21	6
Graduates	19	8
Out-of-State Instructors	9	4
Total	55	24